Improving the Standard of Living in Devikulam, India

EWB Challenge

Joshua Clough, Taylor Crameri, Max McCardel, Matt Power, George Street, Luke Turner
Executive Summary

As part of this project we have been able to put our specified knowledge from our civil engineering education as well as from individual team member assignments on Materials, Infrastructure and utilities, Culture and Social and Buildings to create a solution for the Devikulam community aiming to improve their standard of living.

Our design criteria was developed to maximize the benefit to the quality of life for the Devikulam residence and surrounding people aiming to be overall sustainable; minimizing the environmental impact, keeping cost as low as possible, keeping maintenance simple, providing renewable energy where possible, all the while aiming to please the local community. Using these criteria we have compared our three solutions and from this a solution that we believe would be most effective was chosen.

Included in the proposal is a scheme to discuss with the community the ideas behind the project and allow for input to any changes they feel are necessary. Both before and after construction workshops and activities will occur which will be aimed to educate the community on maintenance of the buildings as well as techniques that could be used in the future for further building and expansion. For a two month period after the construction a phase of initiation and transition will take place where the use of the centre will be monitored and any improvements can be made. This phase will also cater again for education purposes aiming to make the use of the centre easier for all villagers.

We have constructed this report as a collection of our team’s work throughout the design of the project. Our design is described in detail and reasons for our decisions have been explained thoroughly.

Engineers Without Borders’ aim:

The Engineers Without Borders (EWB) project has been designed to allow students to explore potential sustainable solutions for this community to improve the quality of life of the locals. Moreover, the aim of this assignment is to explore certain solutions to the real-life problems that exist in the community including the infrastructure of the town.

The research in this report shows the three solutions that could be employed to improve the quality of life in the Devikulam society.
Team Reflection

From the beginning it was obvious our group didn’t contain the multicultural diversity that other groups possessed that would work in their advantage but we didn’t let that restrain our creative thought processes. Instead we had a vast range of personalities, which in itself could be seen as a make or break factor.

However, from the beginning rather than look at the negatives we put our minds forward and used our advantages to their maximum benefit. We used the combined knowledge of Taylor Crameri, Matt Power, Max McCardel, Luke Turner, George Street and Josh Clough; to come up with three suitable solutions and then broke up into smaller groups to research the solutions.

With the help of our loves for sport the group bonded and was able to work efficiently and effectively together. There has been no clash of personalities with all issues being talked out in a controlled and civil manner until a suitable outcome was reached.

The Engineers Without Borders Challenge provided us all with a way to finally put to practical use our combined knowledge not only in the engineering field but in all aspects of life. Everyone has been highly motivated to improve the quality of life in Devikulam and to help them in whatever way we possibly could. It was thought that as students we could benefit from such a challenge and it has thus been proven. We have grown as people, introverts developing better social skills and extraverts learning to deal with all types of people. We believe the skills this challenge has taught us will allow us to be of better use in a work place on completion of our course.

With the ease of modern technology we did not have any difficulties with communication. Using Facebook to a main communication path rather than travelling the long distances to meet in person when it was not essential, combined with mobile phones we had no issues. When the team thought it was essential to meet as a group, everyone was eager to accommodate each other and find a suitable location. Everyone attended the group meetings and contributed equally.
Table of Contents

Executive Summary .................................................................................................................. 2
Team Reflection ....................................................................................................................... 3
Scope .................................................................................................................................. 5
  Introduction ......................................................................................................................... 6
Criteria for evaluation: ........................................................................................................... 7
Options .................................................................................................................................. 9
  Design Option One: Housing Improvements ...................................................................... 9
  Design Option Two: Transport Improvement ...................................................................... 14
  Design Option Three: Multipurpose Complex .................................................................... 18
Evaluation of Design Options ................................................................................................. 22
  Design Option One .............................................................................................................. 22
  Design Option Two ............................................................................................................. 23
  Design Option Three ........................................................................................................ 25
  Option Selection ................................................................................................................. 26
    Evaluation of Chosen Option ............................................................................................ 27
Health and Education Centre ................................................................................................. 30
  Climate ............................................................................................................................... 30
  Location ............................................................................................................................. 30
  Design ............................................................................................................................... 33
  Timetable and Gantt Chart .............................................................................................. 35
    Outline of the Scheduling ............................................................................................... 36
Social Aspects of Health and Education Centre ..................................................................... 37
  Community Consultation ................................................................................................. 39
  Usage of the Health and Education Centre ...................................................................... 39
  Sustainability ...................................................................................................................... 40
  Materials ............................................................................................................................ 42
  Costing ............................................................................................................................... 45
  Funding Plan ....................................................................................................................... 48
References: ............................................................................................................................ 51
Team Duties ............................................................................................................................ 55
Turnitin .................................................................................................................................... 56
Funding Pamphlet .................................................................................................................. Appendix I
Scope

Project Justification

The reason for undertaking this project and subsequent report has been at the request of Engineers without Borders and Pitchandikulam forest who have chosen the town of Devikulam as the 2011 Engineers without Borders Challenge. The community of Devikulam has asked for the student engineering community to use their current design skills to determine possible ways to improve different areas within the village. Areas suggested requiring attention include: housing, waste management, building construction, transportation, water supply and sanitation systems, and energy.

Additionally this project will provide technological advancements within the town of Devikulam and also the surrounding areas.

If our given option is selected at the final selection phases, it will provide short and long term employment for the community as well as education and health facilities for Devikulam and the surrounding towns.

Project Product

This project will present a possible solution to improve the living standards within the town. It will include monetary costs of the solution, work to be undertaken, methods of construction, materials used and an outline of when the proposed buildings can be used and by whom. The project will not cover who exactly in the town will be responsible for the work undertaken nor will it provide information as to where all the money and other supplies will come from. The subsequent report should be used as a guideline to construction and implementation of the chosen solution.

Project Deliverables

All of the information collated will be presented in one final report. It will contain in depth detail into all the areas covered as to provide the most clarity to the user of the report. It will contain not only the final solution put forward but the preceding options in which the solution was obtained from in order for the user to understand the thought process undertaken and why our chosen solution was the most suitable of the three presented solutions.

The final report will contain AutoCAD sketches of the floor plan layout and its location within Devikulam. The suggested location may not be the final location and the final dimensions do not have to be obsolete, suggestions can be altered as seen fit or at the request of the community.

In addition to the final report, presentations will be conducted throughout the development of the report to gain feedback on areas requiring more attention and also at the conclusion of the report where the solution to follow in this report will be presented in full.

Project Objectives

Our team has developed a large criteria in which will be used to assess the success of the project. It will be covered in full in the report following but its main areas of concern cover:

- Cost
- Town benefits
- Environmental impacts (short term and long term).
Introduction

The community of Devikulam is located in the southern state of Tamil Nadu in India. This village has a population of 358 people (86 families) with each household hosting 4-7 people. The local, common language in the area is Tamil and Religion is Hindu. Most houses in the Devikulam society are made with mud or cement for floors and either thatched or palm leaf for roofing. Farming and agricultural labour are both very common occupations amongst locals, however, a paid employment is quite rare in the area.

Schooling in Devikulam is also quite limited, with only one Primary school, for children aged 5-10, available in the area. Currently, there are 36 students attending this Primary school with only one teacher. Secondary schooling is also just as limited, with the two closest schools being in Nadukappam (4km away) or Marakkanam (16km away), quite large distances to have to travel every day for education. (Devikulam Information, article 1-19)

The central focus point of the village is the beautiful lotus pond, which was once used as a source for fresh water but now is more commonly used for bathing and washing cattle. Whilst the village does host breathtaking scenery and landscape full of lush plant and wild life, the majority of the population in the area is living below the poverty line. Furthermore, the overall quality of the local buildings is poor. (2011 EWB Challenge – Engineers Without Borders Australia, article 3)

In addition, there are growing concerns about the risk of disease spreading due to poor sanitation and also increasing salinity in the water supply. (Devikulam Information, article 1-19)
Criteria for evaluation:

As we can only choose one of the three proposed ideas to implement into Devikulam to improve their quality of life, it is important to develop criteria to rank each proposed idea. We have developed a series of 11 criteria we believe cover the most important aspects of how to improve the quality of life in Devikulam, and listed them in the table below. These criteria are weighted depending on which we believe to be the most important for the community, with 3 different maximum scores, 15, 10 and 5. The maximum possible score for a perfect option would be 115, and the option chosen will be the one which achieves the closest score to this 115 maximum.

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Explanation of Criteria</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Set-Up Affordability</td>
<td>The short term cost of any idea is vitally important; this is the set up cost and will impact greatly on how viable an option is. As Devikulam is a poverty stricken village a good design must be constructed at a low set up cost so it can be afforded.</td>
<td>/15</td>
</tr>
<tr>
<td></td>
<td>Long Term Affordability</td>
<td>The long term cost is the cost of maintaining and running a potential option. Having a low set up cost is made redundant by using technologies with small life spans or high energy consumption.</td>
<td>/10</td>
</tr>
<tr>
<td>Town Benefits</td>
<td>Health &amp; safety benefits</td>
<td>Health and safety benefits to the Devikulam community are amongst the most important aspects of any design. This will include improved healthcare, access to medicines and safety of buildings.</td>
<td>/15</td>
</tr>
<tr>
<td></td>
<td>Education Benefits</td>
<td>Any plan will bring with it education benefits to the community, the locals will have to be taught how to maintain and construct the design, even if the design does not specifically focus on education. This however, is not as vitally important as other aspects such as health and safety.</td>
<td>/5</td>
</tr>
<tr>
<td></td>
<td>Social Benefits</td>
<td>It would be beneficial for a design to aid in forming relationships and friendships in Devikulam, as currently in Devikulam there is some conflict among residents (Engineers Without Borders, 2011). This is not a major issue however, so it is not vitally important to be addressed in all designs.</td>
<td>/5</td>
</tr>
<tr>
<td></td>
<td>Short Term Employment</td>
<td>It is somewhat important that the implemented plan provides employment.</td>
<td>/5</td>
</tr>
</tbody>
</table>
Opportunity opportunities for the people of Devikulam; this would reduce labour costs and also reduce unemployment levels in the village. However, this would be only temporary while the plan in implemented and so it is not as important as long term employment opportunities.

Long Term Employment Opportunity The opportunity an option provides for long term employment is important in ranking the options. Long term employment is a key to reducing the level of poverty in Devikulam and improving the quality of life. /10

Future Prospects India is one of the world’s fastest developing nations (Engineers Without Borders, 2011) and because of this it is important that any option selected for implementation into Devikulam provides opportunity for the village to continue to develop and become a sustainable town well above the poverty line. /15

Cultural Acceptance Culture is of the upmost importance when deciding on which option will be implemented. If a design is not planned with Indian and village culture in mind it may be rejected by the people of Devikulam, hence rendering the entire act pointless. This is what happened with the government housing scheme implemented in Devikulam which has resulted in those houses not being used (Engineers Without Borders, 2011) /15

Environmental Impact Short Term Environmental Impact It is important that the environmental impact of implementing any option is considered, however at this stage it is more important to improve the quality of life for the people of Devikulam and focus more on the long term environmental impact and any potential options. /5

Long Term Environmental Impact The long term environmental impact of any proposal is very important. Because India is developing, it is important to focus on making them as environmentally friendly as first world countries are trying to be, and make as minimal environmental impact as possible. Having a small environmental impact also reduces running costs which is very important for Devikulam. /15

TOTALS /115
Options

Design Option One: Housing Improvements

In order to improve the quality of life in the Devikulam society, certain plans and solutions must be employed.

The first solution proposed by the team is to enhance the living situation of the Devikulam community by creating safer; more insulated and overall improved housing sites.

According to Infrastructure Development, article 2), “poor infrastructure is perhaps the most binding constraint to growth throughout the Asia-Pacific region. Thus with the refurbishment of the housing situation, residents could not only have the opportunity to be employed and construct new works, but also improve morale and enhance the community’s life and spirit.

Due to the unique Devikulam weather and location, it is essential to consider which materials and products would be most suited to improve their housing situation.

This section of the report shows material availability, workability and effectiveness and how housing development is a key solution to improve the lives of the local community.

1.1 Weather

Undoubtedly weather is an essential factor that will alter the design and construction of housing developments.

1,800 meters above sea level, Devikulam’s climatic conditions are generally pleasant throughout the year. During the summer season, between March and May, the town will reach temperatures between 15°C and 39°C.

After the pleasant summer weather, Devikulam then experiences its monsoon season from June to September. The monsoon season brings substantial rainfall to the area. In fact, the month of June averages 615.9mm of rain alone. During this month, Devikulam averages 20.5mm of daily rain. (Meoweather, Devikulam weather history, article 1).

To put this figure into perspective, according to ‘Melbourne, Victoria rainfall, article 2’, Melbourne’s wettest month is October, which is expected to receive 70mm. Thus, in each of their wettest months, Devikulam would expect to receive almost 9 times the amount of rain that Melbourne does. This is certainly a substantial amount of rain.

High humidity is also expected in all seasons, with 80% and above being quite common throughout the year.
1.1.2 The effects of climate on buildings (design and construction)

It is clear that particular materials and designs have been used by the Devikulam society in order to combat the weather. For instance, the villagers have agreed that mud and thatched type housing is the better option, as this is cooler to live in than concrete houses. In fact, those with concrete houses get so hot in summer time that they sleep outside. (INNOVATIONS REPORT extract, Design and Construction, 2011)

In essence, the locals would prefer for their buildings, in particular their houses, to be built with mud and thatched roofing. The thatched roofing lets fresh air in, which cools the house whereas the mud keeps the heat out. It is for this reason that the mud-thatch houses are seen as the best solution to the climate problems.

However, those with mud houses also had complaints, stating that they wanted more protection from the rain and better quality houses.

As mentioned, rain in Devikulam is a common aspect of daily life, thus in order to design new buildings for the community, it would be essential to factor in the large amounts of rain that occur. This would involve utilizing materials that will be unaffected, or at least durable enough, to withstand torrential rain during monsoon season.

1.2 Materials

This section will contain information regarding the material factors the community has to face. Using the ‘triple bottom line’ analysis, areas of improvement can be easily be identified and can also be put into order to give a simple understanding of how to approach this task. In order these are the questions which need to be asked: ‘what materials are being used currently?’; ‘what materials can be considered?’; ‘how abundant are these materials?’, and ‘how are they to be used?’ These simple questions along with a ‘Triple Bottom Line Analysis’, allows for the materials to be easily analysed to give a good understanding of how Devikulam will benefit from smarter thinking.

1.2.1 Current Materials

Building Materials
As the community if Devikulam is in a remote and poor area of India, materials are very limited. They must draw from materials they can easily access and can put to use. These materials include earth (mud, clay), wood and leaves (Palmyra palm leaves) (Engineers Without Borders, 2011).

Triple Bottom Line Analysis
A typical house in Devikulam is about the size of a hut, which consists of mud or cement floors, where the walls are made from mud or burnt brick and the roofs are made from thatched palm leaves. Houses which have been provided by the government are made of burnt brick and concrete and are in desperate need of restoration. Roughly Eighty-Five houses are in the Devikulam community (Engineers Without Borders, 2011).
Economic Factors
- Palm leaves / Earth (mud, clay) are in rich supply, therefore are cheap to harvest and use (Engineers Without Borders, 2011).
- Burnt bricks / Cement are rarer as they have been produced and given from the government. Maintenance of the houses has not been considered and has proven how this was a short term plan. Money is needed to restore the houses to a reasonable standard (Engineers Without Borders, 2011).

Environmental Factors
- The harvesting of palm leaves needs to be monitored to allow time for leaves to grow back, in replace of cropped leaves (Engineers Without Borders, 2011).
- Bricks and cement used for houses leave pollution as they do in cities, however the scale of bricks present in the communities houses is small enough to assume that the environmental footprint is not having a detrimental effect (Engineers Without Borders, 2011).

Social Factors
- Mud thatch houses are cooler to live in however they are less protective against rain (Engineers Without Borders, 2011).
- Concrete houses provide better protection from wind and rain, however are too hot for them to live in, in the summer time (Engineers Without Borders, 2011).
- Many people may live in a single house (Engineers Without Borders, 2011).

1.2.2 First World Materials - Possible Uses in Devikulam

Steel
Steel is definitely not the most essential material India needs for its buildings. Steel would be looked at for the medical centre and the new temple as they need to be safe and large enough structures to hold more than one room. Steel used in housing would not be necessary but could definitely be considered as an option for new roofs.

Concrete
Concrete is to play a significant role in the construction of the Medicare and temple facilities. Those structures must be well protected from the weather and must be well constructed to ensure that it lasts as long as possible without undergoing corrosion, or any other structural difficulties.

Timber
Lumbar will play an essential part in Devikulam structural development. The Palmyra palm tree would be the best way to harvest lumbar locally in Devikulam. Not only does the trunk pose as a great structural resource, but the stems and leafs can also be utilised. As they are grown in the humidity of India they are the perfect lumbar to use. The stems can be mixed with concrete to act as reinforcing and the palm leaves can be used as roofing cover, however they do not keep out all of the rain. Cedar is another type of lumbar which in itself possesses self protecting qualities which repels insects and rotting making it perfect for India’s humid climate. As it is such a good material, it is extremely expensive.
Brick
Brick making is much preferred in Devikulam, as opposed to concrete (Engineers Without Borders, 2011). The main reason being brick can be made locally by the people that will supply jobs for people and gives the community a chance to support themselves rather than relying on outside sources. The process is simple enough for locals to perform which consists of mixing the clay with water and setting them in casts.

Proposed Ideas
Sustainability in a community such as Devikulam is the major factor in this project. As explained, above materials used in our own modern society such as concrete, steel, and carbon, are considered as the most appropriate method of constructing buildings in large and upcoming cities. However, as pointed out, it is not sustainable to use these materials in the surrounding communities of Devikulam and Devikulam itself. Firstly, it is not sustainable to fund the equipment to be brought to the community to construct a minimal amount of buildings. Secondly, it is vital that in the long term the people of the community are to support themselves, and cement and concrete need special equipment to effectively produce. This requires a high level of education which they don’t have. Another point is that transportation of the new materials into Devikulam could be difficult as the roads could get flooded, or are too small to support the forces of large trucks.

Compressed and Stabilised Earth Blocks (CSEB’s)
CSEB’s are much better than making standard burnt bricks. They are compacted tighter thus giving more strength and reducing the effects of corrosion (as no cracks are present) (Auroville Earth Institute, 2011). They are simple enough to make by the community which will stimulate the economy by giving people work. The materials will need to be brought in by EWB as he earth needs to be at the right consistency to optimise strength. These materials are soil, sand, cement and water (Auroville Earth Institute, 2011). Equipment is also needed such as shovels; mumpti’s (backwards shovels with a bent and short handle), gloves and the most important Auram 3000 earth press (Auroville Earth Institute, 2011). The way to construct is to mix the ingredients with a specific ratio, then press it in the presser (Auroville Earth Institute, 2011). These bricks will be most suitable for the new Community hall Centre and the new temples as they are stronger than normal bricks, in which are likely to wear out faster.

Rammed Earth Walls
Rammed earth walls are much the same as CSEB’s however instead of using the Auram 3000 earth press, earth with a good mixture of sand, gravel and clay are pressed into a frame or mould, creating a solid wall or singular blocks. In this case, blocks would be much more efficient because more men and smarter work methods are needed to build the solid walls. The benefits are the same as they are able to last much longer without corrosion and have higher compressive strengths.

Bamboo reinforced concrete
This is aimed to nullify the use of steel acting as reinforcing. Bamboo is cheap and can be found locally which makes it perfect for reinforcing. Bamboo’s ultimate tensile strength is 350-500 MPa (Steel – 400 MPa, Concrete – 3 MPa) (Francis Brink, 1966) which shows that it has the capacity to support concrete structures. The way this concrete is put together is by laying splints of bamboo across each other and pouring the concrete across them (Francis Brink, 1966). Using ¾ inch splints is
the best size for the bamboo, as opposing to using whole columns (Francis Brink, 1966). The workers of Devikulam could easily lay the bamboo however educated workers from EWB would need to come to pour the concrete over the bamboo. This is another suggestion that could work alongside the CSEB’s.

**Bamboo Palmyra and Ferro Cement Composite Roofing**
This process is much the same as the reinforcing in concrete (Francis Brink, 1966). It presents the same principle and addresses the issue of weather protection. However these houses tend to get hot in the summer, bigger windows made of bamboo and leaves should be made to let air flow in and out of the houses.
Design Option Two: Transport Improvement

2.0 Introduction

Transport is and always has been an essential element to societies regardless of the era. Transport encompasses everything from simply going to visit family and friends, to an emergency trip to the hospital where time is of the essence. Our leaders and innovators will always continue to improve the level of transport, improving the time it takes to get to one place, the ease of getting there and additionally the cost associated with getting there (although not strictly financial). However what people often overlook in their lives, is how such simple transport can be seen as an extreme luxury in other countries. We seem to have a never ending supply of public transport and additionally a high percentage of vehicles owned privately by families to meet our needs. However in the small town of Devikulam, India, transport is not so simple. The road quality doesn’t even fall close to the standard that we are used to, simply because of the difficulty associated in the construction and maintenance of such things. During the monsoon seasons, it is not uncommon for roads to be completely flooded leading to them being unusable. In a developing country, simple transport is essential. Transport to obtain food and work, transport for children to travel to places of education facilities and most importantly, transport to medical facilities.

2.1 Current Road structure and quality

There is transport currently available and roads going to most towns, although they are not seen as desirable. In Devikulam, only 12 of the 86 families own a motorcycle and approximately one third of the families own a bicycle (Enginners Without Borders, 2011). These bikes are generally used by the men in the village to travel to and from work, leaving the remainder of the villages, such as the women; children; and elderly; to walk from town to town. Parents have complained that the cost of transporting children to school exceeds the actual cost of schooling for the children, taking up most of their wages. The schools are often 10km or more away. There is a government run scheme that offers bikes free to 11th standard children for travel to school as initiative to keep them in school (Enginners Without Borders, 2011).

The roads in the town of Devikulam are mostly gravel and the same said for the roads around the town. There is a good quality tar road that runs between Devikulam and Nadukupppam, although open defecation is common along the road side (Enginners Without Borders, 2011). The quickest and easiest road to Pondicherry is along a gravel road. However, this is one of those roads that becomes impassable during the monsoon season (Enginners Without Borders, 2011). The residents of Devikulam wishing to travel to Pondicherry must travel along a different path, adding an additional 26km to their trip, each way. This is shown by the map provided by Engineers Without Borders below.
Source: Engineers Without Borders

2.2 Community Needs

One of the key needs for the community is to improve the transport infrastructure to make it easier for residents to move around the village and to the surroundings towns, especially the capital Pondicherry. The community wants to be able to easily travel to the capital all year round, as during monsoon season it is often too time consuming for such a walk, which is so vital for agriculture and the purchase of supplies.

Costs need to be kept low as the community has quite a large number of residents living below the poverty line, whom may not be able to use the new transport infrastructure or vehicles even if they were implemented.

While not essential, transport for children to surroundings schools would be hugely beneficial to the community, not only short term but additionally in the long term. The transport will encourage children whom travel vast distances to stay in school. Continuing the education of the children has a progressive effect throughout society. In turn, each generation we be more knowledgeable than the last, allowing society to continually develop. This is essential if countries are to keep up with the rest of the world and not get left behind, dependant on other countries help and technology.
2.3 Materials for Road Construction:

There are many different types of surfaces that can be used for use in roads, however many would not be suitable for Devikulam for a variety of reasons, including level of maintenance, cost of implementation, cost of maintenance and frequency of use.

**Asphalt:**

Asphalt is the most common road surface in Australia, this is what almost all of our roads are made of, including inner city roads and highways and freeways. There is good reason for this to be the most popular road surface as it has many benefits, it is one of the quickest road surfaces to be constructed. An asphalt road surface laid on the morning of one day will be ready to be used on that same day (Asphalt Pavement Association, 2011). The cost of asphalt is relatively affordable being just $100 per unit of the road surface, and about $175 once the cost of road excavation, curbing and asphalt milling is included. (City of Rockville Maryland, 2010). Asphalt is also commonly used because it has an average life of 40 years which results in lower maintenance costs and more reliability. The surface is also 100% recyclable for when it finally does have to be replaced, which would allow a new surface to be formed with some of the remnants of the old surface making it somewhat environmentally friendly (Asphalt Pavement Association, 2011). A major positive in the use of asphalt as a road surface is its ability to cause water runoff and allow catchment of rainwater. Because it does not allow much water to be absorbed, most water will run off into the guttering on the sides to allow for much more rainwater to be caught, this of course increases the cost greatly due to the extra piping and infrastructure that would have to be constructed (John Clausen, 2006). Despite these positives, asphalt is prone to cracking, and once a crack has formed it will continue to increase in size the more it is used, this may cause a problem for the people of Devikulam because they may not be able to afford a repair of the surface or may not recognise the cracking is occurring and needs to be fixed.

**Gravel:**

Gravel roads are another common type of road with large amounts of benefits for Devikulam, a gravel road is an unpaved road constructed by mixing gravel and crushed rock with loosened dirt and then compacting with a roller. The cost of adding roads is vitally important to the town of Devikulam because of their financial situation, and this is why gravel roads are a very good option in the town, a gravel road is much cheaper than a laying an asphalt road (Kentucky Transportation Center, 2003) it is also cheaper in the long run with maintenance costs being just a fraction of the maintenance cost of asphalt and the effectiveness of maintenance works such as filling in potholes is much higher.
(Kentucky Transportation Center, 2003). The major issue with gravel roads for use in Devikulam is that they absorb much more water than asphalt roads and therefore it would be harder to harvest the rainwater from them, however the more they are compacted the more runoff that will occur.

1.4 Possible Solution

Most importantly we need to ensure there are safe roads between all towns. Maintenance needs to be put into the existing gravel roads to ensure everyone can safely travel on them. Once this has been accomplished the next step is improve the location of roads. Where it is possible, and not largely inconvenient, new roads need to avoid areas prone to flooding. This will ease the cost and time associated with maintenance. Roads which avoid these flood plains will be constructed out of gravel as is it much cheaper than the only other realistic alternative, asphalt, it is also much more practical for the people of Devikulam as it can be maintained much easier and repaired at a much lower cost.

In areas where it is not feasible to avoid flood prone areas or the costs associated without going around far outweigh the costs of redeveloping the existing area, raised asphalt will be put in place. The asphalt shall be raised to approximately 6 inches above the usual flood level to account for a rise in rain in that area. The asphalt will be raised by using cheap local materials, such as adding bamboo underneath and mixed through the tar. Raising the area where floods occur, and constructing these sections of road from asphalt will significantly reduce maintenance costs that would occur if it was still made of gravel. This is because if these sections were made of gravel at ground level they would almost entirely wash away with every rain event, so it is worth the extra initial expense to use raised asphalt and save trouble in the future.

Additionally twice a day, roughly three times a week, a community bus will run to Pondicherry. Attached to the bus will be a trailer so that supplies may be brought back, easing the burden on those in the community. The bus will travel only twice daily to minimise costs, the community will be required to organise themselves to ensure they make this bus or risk having to walk. During the morning and afternoon the bus will be used to transport children to and from schools. All roads travelled by the bus will have to regularly maintained to ensure ease of transport and to avoid damaging the bus, thus causing a cost blowout.
Design Option Three: Multipurpose Complex

3.0 Introduction

There are numerous lifestyle problems found within the Devikulam community that each require some level of attention, therefore it appears beneficial economically, socially and environmentally to identify a solution that combines these needs rather than trying to solve them separately.

This solution proposed by our team is for a multi-purpose community centre to be constructed in Devikulam. This complex would include buildings with functional spaces to be used for education, medical, as a town gathering place, chapel, and a market.

The idea of this space would be to draw many essentials to the liveability of the town into one area to create a central hub to the village.

3.1 Overview

School

Currently Devikulam’s closest high school is 4km away in Nadukuppam, and by foot this journey is far too extended and, during monsoon season, near impossible (Buzza, 2011). The town has schooling facilities for children up to 10 years of age (Buzza, 2011). This proposed centre would be used as a learning/teaching space to educate high school students and mature students with skills that could further benefit the surrounding community.

Medical Facility

The Woman’s Centre is beginning a strategy to introduce medicinal herb gardens to families in the region, apart from this however, the town has no established medical or health service (Buzza, 2011). Therefore to improve the standard of living, reducing spread of disease, and infection, a space to be assigned with basic medical supplies and equipment for a clinic will be included in the design. A touring doctor and nurses would benefit both Devikulam and surrounding villages. A doctor could stay in Devikulam on a rotation schedule, serving nearby rural towns also, and using the medical facility assist with any health issues within the community.

Chapel

Though Devikulam’s Hindu residents already use many chapels in the village, it is a common opinion among them that they could be improved (Buzza, 2011). This centre would include a church/chapel which could be used as a gathering place for the entire community. Connected to the town hall/school, the chapel will also serve as a place for learning and meeting.

Town Market

Farming, agricultural labour and fishing are the major industries in Devikulam (Buzza, 2011). The proposed space for a town market to be used for trading local goods and supplies would benefit the town by allowing local farmers and fisherman to sell their produce rather than travelling vast distances. This market could potentially attract people to the town, enriching the economy.
3.2 Proposed Plan

3.3 Utilities

Energy

Nearly all of Devikulam’s housing is connected to the electricity grid. However, frequent black-outs pose an issue in Devikulam where generators are not affordable or there is not enough training to keep them running and maintained. Due to this issue, this community centre, will be powered with solar panels which would be reliable (i.e. no black-outs – assuming the solar power could be stored), easy to maintain and repair, and would be more environmentally sustainable; the solar panels and thermal technology require minimal maintenance, with most services able to be done by owner after training, though any major faults must be dealt with by a qualified technician (Engineers Without Borders Australia, 2011).

Solar energy will power all lighting, medical equipment, cooling as well as a water pumps.

Water
The medical centre will require a constant water supply when called upon, so the centre will include a small water tank, taking advantage of the added roof area. This water will remain an exclusive supply to only the medical space, and will be connected via plumbing to a tap inside. This method will not require a pump as the tank will be in close proximity to the clinic and gravity based, keeping cost and maintenance as low as possible.

3.4 Additional Town Benefits

Employment

The centre would be seen as an opportunity for employment for many of the townsfolk. There would be positions available for nurses, teachers and for farmers, fisherman and arts and craft stalls to be set up during markets. As well as this, local tradesman would be educated on the construction and maintenance of the buildings and solar equipment so that the same techniques could be implemented in the future.

Culture

The town residents are Hindu (Buzza, 2011), and beliefs include regularly visiting chapels. Although the Devikulam has a number of chapels, the townsfolk believe they could benefit from more. In our proposed design we are including a chapel, an extension of the town hall/school, which is aimed to please the villagers and their culture. This will assist in more easily integrating the project into the already established town.

3.5 Materials

Foundations

Devikulam is in an area that at times is subject to large earthquakes, hurricanes and floods. For these reasons it is vital that the buildings have strong and stable slabs and foundations that can withstand harsh conditions. Conventional concrete slabs often act elastically under heavy pressure or earth movement and causes movement and cracking in the structure (Brink & Rush, 1966). Typically steel is used to reinforce the material, making it more inelastic. However due to the costs, availability and environmental considerations that need to be taken into consideration for the community of Devikulam; bamboo is more appropriate in this situation and effective as a substitute. Bamboo is grown abundantly in the surrounding area as the Government of Tamil Nadu has funded plantations for the benefit of the community, therefore materials can be sourced very easily and cheaply (Pitchandikulam Forest, 2011).

The price of bamboo concrete mesh wall is 26Rs/ft² compared to 5 for mud wall and 40 for brick (Maity, Behera, Mishra, & Majumdar). Although these figures are for walls they can be relatively compared to their price as a foundation. Bamboo reinforced concrete is cheaper than both brick and ordinary concrete and is considerably stronger as the Bamboo’s tensile strength of 350-500MPa adds to concrete’s 3MPa (Brink & Rush, 1966).

Walls
The use of mud brick in houses is very popular in Devikulam due to its availability, cost and its easy construction. Mud brick also has a large thermal mass, larger than most concretes (Your Home, Australian Government, 2010), which in the summer acts to resist the rise in temperature of the outside environment, keeping the house cool. For this reason mud brick houses are preferred to the concrete houses by the inhabitants in Devikulam (Engineers Without Borders, 2011).

Despite these advantages the current houses have a large amount of damage due to the mud bricks low strength and poor craftsmanship.

Stabilized Compressed Earth Blocks (SCEB) utilise local raw earth material and combine it with minimal cement to create blocks with much larger strength than mud brick.

This process is excellent for rural areas as the machine can be transported to a village and immediately start making blocks from soil found on site, limiting the need to transport large loads of bricks or materials to a site. The machine, Auram 3000, requires 6-10 people to operate with only 1 skilled worker. This gives an opportunity for villagers to get involved in the construction process of the houses and thus reducing the costs (Technology and Action for Rural Advancement). The Auram 3000 with block moulds can cost to purchase between 70,000-110,000 Rps (1400-2,200AUD) (AUREKA, 2010). This would be a good investment for the Devikulam community as it can be used for all future projects in the area making them more self-dependant and proving a long term solution.

SCEB’s are similar in colour to the blocks used to construct the houses currently in Devikulam with added thermal insulation properties, strength, uniformity and overall more aesthetically appealing (Technology and Action for Rural Advancement). Therefore this would be an appropriate option for those residents who disliked the current concrete buildings due to the build-up of heat in summer and is why it is the chosen material for the walling in the complex (Engineers Without Borders, 2011).

**Roofing**

Current houses are commonly thatched roofed due to the availability and cost of materials. They also perform better in insulating the house from the heat of India and thus are preferred over the concrete roofs. However inhabitants have complained about their inability to keep water out during monsoon season, therefore it is an unsuitable option for the new complex (Engineers Without Borders, 2011).

Bamboo Palmyra and Ferro Cement Composite Roofing is essentially a version of Bamboo Reinforced Concrete adapted to be lighter and more suitable for roofing. This material will give a much higher level of weather protection; require very little maintenance however may be too hot during the summer. This can be altered by introducing larger windows and vents to allow air to circulate through the house.
The price of this composite roofing will be similar to the Reinforced concrete used in the slab and will also require some skilled workmen to overlook the construction of the building.

**Evaluation of Design Options**

**Design Option One**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Score</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Set-Up Affordability</td>
<td>2/15</td>
<td>The ferrocement composite roofing in particular will cost a high amount to initially set up and train</td>
</tr>
<tr>
<td></td>
<td>Long Term Affordability</td>
<td>8/10</td>
<td>As part of the design, most of the materials used to develop the housing are durable. This implies that little maintenance is required and thus a long-term cost will not affect this solution too much.</td>
</tr>
<tr>
<td><strong>Town Benefits</strong></td>
<td>Health &amp; safety benefits</td>
<td>7/15</td>
<td>In terms of health and safety, housing development will protect villagers from outside environmental forces. This should reduce the chance of colds and flues.</td>
</tr>
<tr>
<td></td>
<td>Education Benefits</td>
<td>2/5</td>
<td>The construction of the houses will teach members of the community certain construction procedures.</td>
</tr>
<tr>
<td></td>
<td>Social Benefits</td>
<td>2/5</td>
<td>Socially, housing developments will not be entirely effective.</td>
</tr>
<tr>
<td></td>
<td>Short Term Employment Opportunity</td>
<td>3/5</td>
<td>In the short term, community members will be hired to help construct and amend their houses</td>
</tr>
<tr>
<td></td>
<td>Long Term Employment Opportunity</td>
<td>2/10</td>
<td>As mentioned, there is no real maintenance needed to keep the housing developments operational, thus there are no long term employment opportunities</td>
</tr>
<tr>
<td></td>
<td>Future Prospects</td>
<td>4/15</td>
<td>Villagers may incorporate the discussed design and construction methods into all their new works and developments in the future</td>
</tr>
<tr>
<td></td>
<td>Cultural Acceptance</td>
<td>10/15</td>
<td>The locals would surely welcome new improvements made to their houses</td>
</tr>
<tr>
<td><strong>Environmental Impact</strong></td>
<td>Short Term Environmental Impact</td>
<td>4/5</td>
<td>There is no apparent environmental impact in this proposal</td>
</tr>
<tr>
<td>(high score = less environmental impact = good)</td>
<td>Long Term Environmental Impact</td>
<td>14/15</td>
<td>After set up there would be almost no environmental impact from this option</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td>58/115</td>
<td></td>
</tr>
</tbody>
</table>
# Design Option Two

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Score</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Set-Up Affordability</td>
<td>8/15</td>
<td>It will be expensive to implement a full upgrade of roads in and around then Devikulam village as well as adding a few, however it is being done as affordably as possible by using gravel in all possible areas. The road surface itself may be cheap, but machinery and labour will make the project expensive.</td>
</tr>
<tr>
<td></td>
<td>Long Term Affordability</td>
<td>7/10</td>
<td>Once the plan has been implemented and is running smoothly, there should not be any large costs associated with keeping it going. There will be some maintenance costs associated with the upkeep of the gravel roads; however it is cheaper to maintain and repair gravel than the alternate option, asphalt. There may also be some costs involved with maintenance to the bus, and fuel prices, but this will be minimal.</td>
</tr>
<tr>
<td></td>
<td>Health &amp; safety benefits</td>
<td>11/15</td>
<td>The improvements to the road and transport with buses being added means it is much easier for people to get to surrounding towns for much needed medical treatment. The improvement to the road surfaces means there will be safer to drive on and there will be a large reduction in the chance of being injured while using them.</td>
</tr>
<tr>
<td></td>
<td>Education Benefits</td>
<td>3/5</td>
<td>Having a bus to the nearby schools will provide an opportunity for the children of Devikulam to attend school in nearby villages and gain an education through those schools. However, this is still not as good as having a school built in Devikulam.</td>
</tr>
<tr>
<td></td>
<td>Social Benefits</td>
<td>3/5</td>
<td>Having transport available to neighbouring towns and villages gives the people of Devikulam a chance to meet other people, socialise and make friends with new people. This does have a negative impact though; it may mean that the already strained relationships between people in Devikulam become worse because they do not have to spend time together working out their problems.</td>
</tr>
<tr>
<td></td>
<td>Short Term Employment Opportunity</td>
<td>4/5</td>
<td>The works upgrading and constructing new roads will require a lot of workers. This will mean there will be a good opportunity for many of the people of Devikulam to gain employment working on the roads.</td>
</tr>
<tr>
<td>Long Term Employment Opportunity</td>
<td>7/10</td>
<td>After the work implementing the plan has been done the roads won’t directly create new jobs, except for a small maintenance team and a few bus drivers. It will however, provide an opportunity to travel more easily to other towns and seek employment there, this will increase the level of employment in Devikulam.</td>
<td></td>
</tr>
<tr>
<td>Future Prospects</td>
<td>11/15</td>
<td>The addition of new roads and improvement of old roads will open the door for future development in the area. It will make it easier for goods to get in and out of the town, a major factor for developing areas.</td>
<td></td>
</tr>
<tr>
<td>Cultural Acceptance</td>
<td>10/15</td>
<td>The local people of Devikulam do not particularly like things being changed or added by third parties. We saw this with the Government housing which was put in place and not even used by the villagers. For this reason they may not fully accept the new roads at first. However the use of gravel and compressed dirt to construct the roads makes them more natural and more like what the people of Devikulam would make themselves than if they were to be made of asphalt. For this reason, it is fair to assume there would be some level of cultural acceptance.</td>
<td></td>
</tr>
<tr>
<td>Environmental Impact (high score = less environmental impact = good)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Term Environmental Impact</td>
<td>3/5</td>
<td>The use of gravel and compressed dirt as a road surface has a much lower environmental impact than the use of asphalt which was the alternative. There will be a negative environmental impact from the machinery that is used to construct the roads.</td>
<td></td>
</tr>
<tr>
<td>Long Term Environmental Impact</td>
<td>7/15</td>
<td>With improved roads and new roads there will be more transport and use of fossil fuels. This will mean there is going to be an increase in environmental impact in the long run. The bus service will also add considerable amounts of pollution to the existing levels.</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td><strong>74/115</strong></td>
<td></td>
</tr>
</tbody>
</table>
Design Option Three

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Score</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Set-Up Affordability</td>
<td>9/15</td>
<td>The construction and transportation of materials used to build the complex will be very large as some materials may need to be sourced from over 100km away over poor quality roads. Also some skilled labourers will need to be employed to oversee the building.</td>
</tr>
<tr>
<td></td>
<td>Long Term Affordability</td>
<td>8/10</td>
<td>Several personnel must be employed such as teachers and a doctor/nurse to run the facilities. Occasional low maintenance cost.</td>
</tr>
<tr>
<td><strong>Town Benefits</strong></td>
<td>Health &amp; safety benefits</td>
<td>13/15</td>
<td>A medical area is proposed that will give a clean sterile environment for minor injuries and illnesses to be assessed and treated. A doctor or nurse will visit the town and surrounding rural areas on a scheduled tour to ensure health assistance is evenly spread.</td>
</tr>
<tr>
<td></td>
<td>Education Benefits</td>
<td>5/5</td>
<td>This proposed centre would be used as a learning/teaching space to educate high school students and mature students with skills that could further benefit the surrounding community.</td>
</tr>
<tr>
<td></td>
<td>Social Benefits</td>
<td>4/5</td>
<td>Getting the community actively involved in the project (through manual labour or through the designing and decorating of town hall/chapel) will help unite the often separated ranks of their society. The town centre will act as a meeting place for markets, town meetings and town functions that all the community can participate in.</td>
</tr>
<tr>
<td></td>
<td>Short Term Employment</td>
<td>4/5</td>
<td>A number of people will be required to supply manual labour to build the buildings.</td>
</tr>
<tr>
<td></td>
<td>Opportunity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long Term Employment</td>
<td>8/10</td>
<td>Jobs as teachers, doctors or nurses (for the qualified), cleaners and other staff will be created.</td>
</tr>
<tr>
<td></td>
<td>Opportunity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Future Prospects</td>
<td>10/15</td>
<td>The addition of a secondary and trade school will give the people of Devikulam more opportunities to further their education and make themselves more self-reliant. This will overall help the community help themselves and begin the process of increasing their standard of living. The addition of a medical centre will boost the popularity of the town and change the lifestyles of the town residents.</td>
</tr>
</tbody>
</table>

Cost can be split up into two categories, short term cost and long term cost.

There are a wide range of town benefits to come from any development in Devikulam, including health and education benefits.
The town residents are Hindu and beliefs include regularly visiting chapels. Although the Devikulam has a number of chapels, the townsfolk believe they could benefit from more. In our proposed design we are including a chapel, an extension of the town hall/school, which is aimed to please the villagers and their culture.

Environmental Impact
(high score = less environmental impact = good)

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Short Term Environmental Impact</th>
<th>Long Term Environmental Impact</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cultural Acceptance</td>
<td>9/15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The town residents are Hindu and beliefs include regularly visiting chapels. Although the Devikulam has a number of chapels, the townsfolk believe they could benefit from more. In our proposed design we are including a chapel, an extension of the town hall/school, which is aimed to please the villagers and their culture.</td>
<td>The sourcing of materials will require some clearing of land in the Devikulam area as well as the cutting down of local bamboo and Palmyra trees.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental Impact</td>
<td>3/5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some medical wastes created, water used and occasional materials used for maintenance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>83/115</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Option Selection**

Upon rating each design option based on the areas of overall costs, health and safety benefits, education benefits, future prospects, cultural acceptance and environmental impact it was evident that the option chosen to be further developed would have to be a modification of option three, the “multi-purpose centre”. The option currently is by far the best design option of the three for improving the standard of life in Devikulam, however is clearly much too expensive for their town, and too difficult to implement in a short amount of time. Upon discussion of these issues it has been decided that the final and best solution to the poor quality of life in Devikulam will have to be a revised version of option number three. This revised version will no longer be known as a ‘multi-purpose centre’, but will be known as a ‘health and education centre’. The changes to the design have minimal reduction in the benefit to the town, while maximising the affordability and bringing down the cost as much as possible.

The chapel that was to be included in the original ‘multi-purpose centre’ will no longer be included in the proposed centre. This will obviously have an effect on the level of cultural acceptance of the centre, as the people of Devikulam believe there can never be too many chapels; however this reduction will be minimal and offset by other factors. By reducing the centre to just health and education means there can be more focus put on these two areas which will offset the reduction in cultural acceptance. The extra focus on education will allow the people of Devikulam to gain a greater knowledge of the environment and world, and this will allow them to construct a new chapel in the future if they believe it is necessary. The major offset for this loss in cultural acceptance will come from the dramatic reduction in cost, the cost of materials and labour for the chapel section of the centre will be saved, along with the materials and labour for the town hall/education facilities as now they will only be used for education. This will also result in greater future prospects as there will be higher focus on education and it will mean less people have to be immediately educated to help in construction and there will be a lower number of workers to pay for.

The health and education centre will incorporate four of the eight Engineers Without Borders specified design areas. The design areas addressed by this health and education centre are as listed:

- Building and Construction
- Water Supply
- Energy
- Information and Communication for Education
The design area ‘Water Supply’ will not be covered in the sense of providing the entire community with a water source, but it is covered in the construction of a water tank to get water into the medical centre, as this will be crucial for cleaning instruments and for other uses in the medical centre.

This revision of the ‘multipurpose centre’ to now become a ‘health and education centre’ will now be rated against the same criteria for determining overall benefit to the quality of life in Devikulam. If it achieves a higher score than the original design option three, as it is expected, every aspect of making it work will be further researched so a more detailed proposal can be submitted to Engineers Without Borders.

**Evaluation of Chosen Option**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Score</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Set-Up Affordability</td>
<td>9.5/15</td>
<td>The construction and transportation of materials used to build the complex will be very large as some materials may need to be sourced from over 100km away over poor quality roads. Also some skilled labourers will need to be employed to oversee the building. The amount of materials and labour will be much lower than the original plan for the ‘multi-purpose centre’ as there will no longer be a chapel, and the town hall will be reduced in size to only be used as a school. This reduction in uses will also save money in internal fittings for the buildings.</td>
</tr>
<tr>
<td></td>
<td>Long Term Affordability</td>
<td>8/10</td>
<td>Several personnel must be employed such as teachers and a doctor/nurse to run the facilities. Occasional low maintenance cost.</td>
</tr>
<tr>
<td><strong>Town Benefits</strong></td>
<td>Health &amp; safety benefits</td>
<td>11/15</td>
<td>A medical area is proposed that will give a clean sterile environment for minor injuries and illnesses to be assessed and treated. A doctor or nurse will visit the town and surrounding rural areas on a scheduled tour to ensure health assistance is evenly spread. This health centre will remain, allowing the same health and safety benefits in the revised option as the original ‘multi-purpose centre’ proposal</td>
</tr>
<tr>
<td></td>
<td>Education Benefits</td>
<td>5/5</td>
<td>This proposed centre would be used as a learning/teaching space to educate high school students and mature students with skills that could further benefit the surrounding community. Reduction of uses for the centre in the revised option, will allow for more teaching time and better teaching.</td>
</tr>
<tr>
<td>Social Benefits</td>
<td>4/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Getting the community actively involved in the project (through manual labour or through the designing and decorating of town hall/chapel) will help unite the often separated ranks of their society. The town centre will act as a meeting place for markets, town meetings and town functions that all the community can participate in. This area will remain in the revised option, which will therefore allow for the same social benefits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Short Term Employment Opportunity</th>
<th>3/5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A number of people will be required to supply manual labour to build the buildings. With a smaller amount of construction being undertaken with the revised option, there will be slightly less jobs made available.</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Long Term Employment Opportunity</th>
<th>7.5/10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jobs as teachers, doctors or nurses (for the qualified), cleaners and other staff will be created. However, fewer jobs will be created as the revised option is smaller in size to the original ‘multi-purpose centre’</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Future Prospects</th>
<th>11.5/15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The addition of a secondary and trade school will give the people of Devikulam more opportunities to further their education and make themselves more self-reliant. This will overall help the community help themselves and begin the process of increasing their standard of living. The addition of a medical centre will boost the popularity of the town and change the lifestyles of the town residents. These benefits along with the revision to make it the centre only health and education will allow for more focus to be put on these aspects, this will allow for better education for the children of Devikulam who will be responsible for the future development of the town.</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultural Acceptance</th>
<th>10/15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Although the original design option three included a chapel, it was small insufficient. The design will still make use of local building materials and not look like the grey cement buildings which were implemented by the government and rejected by the townsfolk. The gained knowledge from the extra focus on education will allow the people of Devikulam to construct another chapel, of reasonable size in their town which will be more beneficial to their culture than the one</strong></td>
<td></td>
</tr>
</tbody>
</table>
which was originally going to be constructed.

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Short Term Environmental Impact</th>
<th>Long Term Environmental Impact</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Impact</strong></td>
<td><strong>Short Term Environmental Impact</strong></td>
<td><strong>Long Term Environmental Impact</strong></td>
<td><strong>TOTALS</strong></td>
</tr>
<tr>
<td>(high score = less environmental impact = good)</td>
<td>3.5/5</td>
<td>11/15</td>
<td>84 /115</td>
</tr>
<tr>
<td>The sourcing of materials will require some clearing of land in the Devikulam area as well as the cutting down of local bamboo and Palmyra trees. With less materials being needed in the revised option than the ‘multi-purpose centre’ due to the removal of the chapel and reduction of town hall size, the environmental impact associated with construction will be lower.</td>
<td>Some medical wastes created, water used and occasional materials used for maintenance. The environmental impact will be reduced from that of the ‘multi-purpose centre’ option as there will be less amount of energy used due to the significant reduction in size</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After rating the revised option three, it can be seen that there is a clear improvement in how well the option will aid in improving the quality of life in Devikulam over the original best option, the multi-purpose centre. The revised option achieved a score that is 6 points higher in rating than the option it was derived from, meaning this is the option we will now finish developing and researching. A detailed report of this chosen design option will be constructed.
Health and Education Centre
Our solution consists of a two separate building. The smaller of the two to be used as a health facility and the larger to be used as an education centre. Both buildings will be supplied water from a 10,000L water tank. Electricity has been proposed to be provided through the use of solar panels and use of the National Grid.

Climate
Devikulam is located in the state of Tamil Nadu, the southernmost state of India and therefore has a very tropical climate. There is only little difference between summer and winter temperatures as a result of this, with the weather being humid all year round. During the months of October to December a northeast monsoon affects Devikulam and the rest of Tamil Nadu (Renaissance Reizen, 2009). Rainfall during this period has known to be very intense. Monsoon season has a huge affect on the lives of the residents of Devikulam, affecting not only the way they travel but additionally the design of their houses. The average yearly rain fall is between 635mm and 1,905 mm (Renaissance Reizen, 2009).

April to June is the hottest part of the year in Tamil Nadu, with the temperate rising to a scorching 40°C (Renaissance Reizen, 2009). It can also be very humid in parts in Tamil Nadu, during summer this makes for very uncomfortable nights in Devikulam where some of the houses are poorly designed and do not have the characteristics to effectively deal with this weather. The winter period, December to February, is the coolest time of the year with the temperature averaging a comfortable 20°C although it is still known to be rather humid (Renaissance Reizen, 2009).

Location
Devikulam, Nadukuppam Panchayat, Villupuram District, Tamil Nadu, Índia (Buzza, 2011)

Devikulam is located in the state of Tamil Nadu, the southernmost state of India and therefore has a very tropical climate. There is only little difference between summer and winter temperatures as a result of this, with the weather being humid all year round.

Source: (Google)
Shown in the below maps, sourced from Google and Engineers Without Borders, is our proposed location for our education and medical facilities. Highlighted by the red circle, we chose this location due to its location within Devikulam. There is already a large cleared area of land, allowing for minimal deforestation, which in itself could cause resistance from the community.

The area is central Devikulam, allowing ease of access by all those in the community. It is rather close to the government housing, this means those who require it most, have the best access to the facilities.

Additionally the area is located in close proximity to the town hall, adding value to the facilities. The whole system will be then able to work together and allow the residents of the Devikulam the best possible use of them. The site is also located within walking distance of the primary school, easing the transition between schools and allowing teachers to travel between the two schools if need be.

Source: (Google)
Source: (Google)

Source: (Engineers Without Borders, 2011)
Layout

The Education and Medical centres are situated near each other as it is hoped that they will interact to further assist in the education of the community. The close proximity of the buildings also reduces the costs in building and maintaining the structures, and allows them to share a solar electricity system and water tank making them almost completely self-sustainable.

Educational Centre

The Educational Centre is composed of a 15m long, 8m wide and 2.5m high building located at the north of the entire area. The long dimensions were chosen to allow the building to be separated into two rooms that give enough space for classes to be held. This building is then separated into two separate rooms through a set of wooden bi-fold doors that can be opened or closed at any time and is also accessed via two single wooden doors on the southern side. Bi-fold doors have been utilised in preference to permanent walling as it gives the building many more uses. For example the smaller rooms are ideal for normal school class use, splitting up the students and allowing for more efficient and comfortable learning/teaching. When the doors are open the space can be transformed into an excellent area for town meetings, performances (musical or theatrical), a town evacuation safe house or many other social events.

Medical Centre

The Medical Centre is located to the south east of the educational centre and is a square 8m by 8m building. The building is one entire large room separated into sections by curtains that run on rails, similar to those found in most Australian hospitals. These are used to minimise the cost and space wasted whilst giving the patients with an appropriate amount of privacy. The largest of the rooms will be used as a waiting area where people who wish to see the touring doctor(s) can wait for their turn. There will also be 4 other smaller sections where the appointments and procedures will take place. Two of them contain hospital style beds which patients can rest and recover whilst the other two areas are primarily for medical consultation and diagnosis for small illnesses or injuries.
# Timetable and Gantt Chart

(Dates are only an example; actual starting date will need to be discussed once project is presented).

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Predecessors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding Plan</td>
<td>5 months</td>
<td>Fri 14/10/11</td>
<td>Thu 1/03/12</td>
<td></td>
</tr>
<tr>
<td>Making of Bricks</td>
<td>15 days</td>
<td>Fri 2/03/12</td>
<td>Thu 22/03/12</td>
<td>1</td>
</tr>
<tr>
<td>Clearing the Allocated Land</td>
<td>2 days</td>
<td>Fri 2/03/12</td>
<td>Mon 5/03/12</td>
<td>1</td>
</tr>
<tr>
<td>General Excavation and Preparation for Slab</td>
<td>5 days</td>
<td>Tue 6/03/12</td>
<td>Mon 12/03/12</td>
<td>3</td>
</tr>
<tr>
<td>Pouring of Slab</td>
<td>1 day</td>
<td>Tue 13/03/12</td>
<td>Tue 13/03/12</td>
<td>4</td>
</tr>
<tr>
<td>Slab Setting</td>
<td>5 days</td>
<td>Wed 14/03/12</td>
<td>Tue 20/03/12</td>
<td>5</td>
</tr>
<tr>
<td>Construction of Frame</td>
<td>5 days</td>
<td>Wed 21/03/12</td>
<td>Tue 27/03/12</td>
<td>6</td>
</tr>
<tr>
<td>Walls and Electrical Roughs</td>
<td>5 days</td>
<td>Wed 28/03/12</td>
<td>Fri 30/03/12</td>
<td>7,2</td>
</tr>
<tr>
<td>Roof</td>
<td>5 days</td>
<td>Mon 2/04/12</td>
<td>Fri 6/04/12</td>
<td>8</td>
</tr>
<tr>
<td>Gutters, Plumbing and Water Tank</td>
<td>2 days</td>
<td>Mon 9/04/12</td>
<td>Tue 10/04/12</td>
<td>9</td>
</tr>
<tr>
<td>Installation of Doors, Windows and Trim</td>
<td>2 days</td>
<td>Wed 11/04/12</td>
<td>Thu 12/04/12</td>
<td>10</td>
</tr>
<tr>
<td>Finish Electrical</td>
<td>2 days</td>
<td>Fri 13/04/12</td>
<td>Mon 16/04/12</td>
<td>11</td>
</tr>
<tr>
<td>Installation of Medical Equipment and Fixtures</td>
<td>5 days</td>
<td>Tue 17/04/12</td>
<td>Mon 23/04/12</td>
<td>12</td>
</tr>
<tr>
<td>Landscaping and Overall Finishing</td>
<td>5 days</td>
<td>Tue 24/04/12</td>
<td>Mon 30/04/12</td>
<td>13</td>
</tr>
<tr>
<td>Transition Period of Initiation and Education</td>
<td>60 days</td>
<td>Tue 1/05/12</td>
<td>Mon 23/07/12</td>
<td>14</td>
</tr>
</tbody>
</table>
Outline of the Scheduling
(B4UBuild, 2010)

1. Funding Plan (as previously outlined), a combination of fundraising and grants.

2. Making of bricks using the Auram 3000 compressed block maker

3. Clearing the allocated land will require clearing all shrubbery and trees that will be required to make room for development.

4. General excavation and preparation for slab includes grading of land, digging for footings, laying footing and reinforcement as well as laying initial sand layer for slab.

5. Pouring of slab, filling the prepared excavated and reinforced regions with concrete.

6. Slab setting, allowing adequate time for the concrete to set before continuing with construction of the frame and walls.

7. Construction of frame, carpentry including construction and installation of wall framing and roof trusses as well as door and window frames.
8. Walls and electrical roughs, includes initial placement of electrical through walls in preparation for solar panels and electrical equipment, medical, etc and the installation of the electrical service panel. After this, walls will be constructed using previously made blocks from the Auram 3000.

9. The roof construction involves positioning of metal sheeting over the roof truss.

10. Gutter, plumbing and water tank, the installation of gutters on the roof and piping to the water tank. From there a tap will be introduced on the outside of the tank to access the water resource.

11. Installation of doors windows and trim includes the placing and alignment of all windows and doors and ensuring the building is sealed correctly.

12. Finishing of electrical involves the installation of solar panels and connecting of all wiring and power points, switches and plugs.

13. Installation of medical equipment and fixtures, connecting of all appliances and installation of beds, desks, chairs, curtains, etc.

14. Landscaping and overall finishing construction of path and gardens, including picnic tables, painting of interior and exterior. From now the centre is able to be used by the entire community.

15. Transition period where the community will be consulted and educated to the benefits of the centre, where they will be taught on the ways to maintain the centre and the first classes will be held. This period will also be used to monitor the effectiveness of the centre so any weakness can be addressed to overall benefit the long term effect of the project.

Social Aspects of Health and Education Centre

The health and education centre proposed to be implemented into the small rural village of Devikulam in India will, along with considerable education and health benefits, bring large improvements in the social environment in Devikulam. Currently the there is some resentment among the people of Devikulam as some villagers have more money, and a slightly better quality of life than others (EWB). The proposed design aims to significantly reduce, or eliminate this resentment as well as improve friendships and relationships in the village.

The inclusion of a public space to be used for markets twice a month, for local farmers and fishermen to sell or trade their produce with the other local residents will significantly improve the social environment of the village. Being a small town, these markets will most likely draw all, or the vast majority of the residents into one central location, which will encourage socialising and getting to know each other better. The wide range of benefits to the social environment of Devikulam include:

- **Building networks** - This happens due to the socialising with others in the local community, in particular the other farmers or craftsmen in the area. Building these kinds of networks helps greatly in the opportunity to further develop in the future.

- **Improve family relationships** – Family relationships can be improved by visiting the markets and spending the day together, this will mean the families are together more and will grow closer.
- **Improve friendships** – As people could visit the market as a family, they could also attend in friendship groups allowing these relationships to improve too. There could also be improved friendships between farmers who used to see each other as competitors.

- **Benefit health (due to more fresh, healthy food)** – Farmers markets are known for their fresh, healthy produce. This would be bought or traded for by more locals who will proceed to eat healthier food than previously.

- **Generate a sense of community** – These farmers markets will attract almost the entire town, this is going to be very good in creating a sense of community among the townspeople. As this sense of community grows, they may be able to work together to increase the size of the market so that people from nearby townships could attend too.

(Kennon & Coster, 2005)

There are also many benefits to the Devikulam village social environment associated with the education and schooling section of the centre. This education centre will get many people of the younger generations socialising together. This will result in better friendships and more friendships within the community which will help reduce the resentment in future generations. This could also help reduce the current resentment as the parents of those attending the school will be less likely to resent the parents of their children’s friends. The new education centre will bring along with it many social benefits that come with schools, such as:

- **Students make new friends** – It is natural that, while at school students will form friendships, many which will stay with them for life. In such a small community these friendships are of the upmost importance. The friendships formed during the time spent at the school, will allow trust to be formed in each other which will be very important for future development.

- **Increase knowledge among townspeople** – The school will teach people the skills required to live a good life as well as provide them with the necessary information to further develop their village on their own. As this development occurs, the social issues such as resentment among villagers will be reduced. The knowledge and skills learnt will also allow the townspeople to help each other out when constructing or performing maintenance on various constructions. This ability and willingness to help out will also improve friendships and trust in one another.

- **Improve existing friendships/relationships** - It is natural, that just as new friendships will form from this education centre, existing friendships will be improved and become stronger. As Devikulam already has a primary school, the students will most likely arrive at this education centre with some friendships already formed, these friendships will become stronger.

- **Reduce crime** – There is no large crime issue in the town of Devikulam currently, but as in all villages and towns there is a little bit. Schools are known to work to reduce crime by getting the youth off the street and doing something proactive as well as giving them the education to pursue other career paths, and teach the importance of earning an honest living.

- **Improve tolerance of townspeople** – One area of focus at the school will be to teach tolerance. It is important to improve the tolerance of the townspeople so that the current resentment between villagers due to financial situations can be reduced, and eliminated from the younger generations, hopefully the tolerance gained will ensure that this resentment does not return.

(Preston & Green, 2003) (Riddell, 2004)
Community Consultation

Community Consultation not the most important aspect of the project however the people of Devikulam still need to know what is going to happen to their community. The most efficient way to inform the people is to hold a meeting between EWB employees and an advisory committee of Devikulam. The Advisory Committee should consist of asdfads and about 6 of the other more educated people in the community. This way once the information has been passed out to the advisory committee, they can then hold their own meeting with the whole community. This way the people feel like they can trust the decision that is being made. EWB is a trusted organization therefore I believe the people of Devikulam won’t have any problem with the projects which have been finalized.

Another aspect of the consultation is to appoint jobs for the construction of the building. This, once again, can be allocated by the advisory committee.

Usage of the Health and Education Centre

Designing a Health and Education centre will develop and enhance the structure, morale and integrity of the Devikulam community. The proposed centre has several benefits including enhancing education, health and community morale.

Educational purposes

Currently, the closest high school is 4km away in Nadukuppam which by walking is quite a lengthy journey to travel. Furthermore, during the monsoon season, the direct road from Devikulam to the high school becomes flooded and inaccessible; resulting in students having to travel a further distance of 12km, just to attend school. (Buzza, 2011)

The team has designed a building which could host learning and teaching environment. Students of all ages could attend and due to the close proximity of the new proposed learning facility, high levels of engagement would be expected.

It is predicted that there would be two classes that would host around 30 students in each. Specific aspects that would be taught in this schooling environment would be practical lessons including, basic mathematics, farming, building and agricultural skills as well as English.

Enhancing the academic potential of the community will aid improving the standard of living in Devikulam and increase the opportunity of receiving or creating new jobs to locals.

Medical purposes

A building has also been assigned by the team to host medical procedures and health services. The medical centre would have traditional medicinal herbs that can combat against certain diseases and infection.

Furthermore, a touring doctor would be in place to check up on patients during scheduled times of the week. This doctor could also travel to other local, rural areas of India.
Incorporating a medical centre in the design will improve the overall health of the community and having a qualified doctor on a rotation schedule could teach the locals how to reduce the risk of spreading disease. Consequently, this is certainly a beneficial building to have.

**Town market**

In the centre of the buildings, a market area has been proposed. Here a range of goods may be traded or purchased that would come from farming, agricultural, arts and fishing industries. Not only would this increase the economic wealth of the community but it would also potentially attract people to the town.

The team believes that this Health and Education centre proposal is the most beneficial means of improving the standard of living within the Devikulam community.

**Sustainability**

It is essential as engineers to design and implement a solution for the Devikulam society that is not only useful in the immediate future, but can be maintained and remain beneficial to future generations. In order to produce such a solution, the team has incorporated specific proposals that will fulfil the sustainability aims of the project.

**Solar panels**

Devikulam is an incredibly sunny area of India, roughly expected to receive 2,000-2,600 hours of sunlight per year (Weather and Climate, 2010). For this reason, the team believes it would be quite beneficial to harness the solar energy and invest in this renewable energy source.

At the moment, nearly all of the housing and facilities in Devikulam are connected to grid power. However, blackouts are quite a frequent occurrence and thus solely grid power is not an entirely reliable means of powering the town.

One possible solution to this would be the installation of generators in the town; however this comes at quite a high price and requires maintenance and skilled training to operate. As a result, this is not an ideal outcome for Devikulam.

Conversely, another option is to install solar panels in Devikulam to store energy and power certain areas of the community. The energy stored in the solar panels would be predominantly used for the Health and Education centre, ensuring any electrical medical or educational electrical equipment would have a constant, reliable source of power.

India has a range of solar panel manufacturers located throughout the country. In fact, solar energy in India is one of the most exponentially growing industries in the world (Solar Power in India, 2011).

Moserbaer Solar is an Indian company situated in New Delhi that manufacture and distribute solar panels to vast locations. (Moser Baer Solar Limited, 2010) Using this resource, with correct funding the Devikulam community could invest in solar panels.
It is also critical to consider the cost of the solar panels. The team has estimated that the price of installation and production of solar panels would be approximately $10,000 - $20,000 AUD. (Ecoworld, 2003) At first glance; this may seem like a high cost to pay, however considering the environmental and contextual benefits, the team believes this to be a worthy investment.

This solution of incorporating solar panels into the design of the Health and Education centre will create a sustainable project that does not rely on grid power and fossil fuels, but rather natural, renewable resources.

Water Tank

Due to the importance for the medical facility and education centre to be supplied with fresh water for drinking, cleaning and washing it has been decided that a water source must be created that is easily accessible and partially exclusive to the centres.

The large rooftop areas of each building will provide a good source of water runoff which will be channelled through rain gutters and PVC piping to a tank situated between each of the buildings.

Using the average rainfall of 1217ml per year in Chennai (Climate Temp 2011), roughly 100km to the north of Devikulam, the total runoff from the two buildings can be calculated.

\[
\text{Annual water runoff} = \text{Roof area} \times \text{annual rainfall} \times \text{coefficient}
\]

\[
\text{Roof area} = 214m^2 \quad \text{Coefficient} = 0.8 \quad (\text{Knowledge for Rural Development n.d.})
\]

\[
\text{Runoff} = 214 \times 1217 \times 0.8
\]

\[
= 208,350 \text{ L/year}
\]

Choosing the size of the tank is important as costs must be minimized whilst still containing a volume suitable for long periods without rain. The size of the tank must be adequate enough to hold the water required throughout an extended period of time without rain.

\[
\text{Capacity} = \text{Most days without rain} \times \text{average daily consumption of water}
\]

\[
= 265 \times 50 = 13,250 \text{ L}
\]

265 days of no rainfall are based on the average total number of days (Climate Temp 2011), not the consecutive amount therefore it is safe to assume the required amount of water would be considerably less than this amount. The chosen tank size will therefore be 10,000 L (found at this source (Enviro Friendly Products 2011)), which will be filled easily by the yearly rainfall and whilst retaining enough water to supply the buildings with water throughout the entire year.

The dimensions of the tank will be diameter\(= 2.70m\) and height \(= 2.35m\).

Based on the Australian price, the tank will cost around $1700 plus an extra $100 for PVC piping and taps to attach to the buildings.
Materials

Many Integrated materials have been researched and there are many options which could be used, however one material must be chosen above the rest for each aspect of the Multipurpose Complex. The Complex needs to be able to last for a significant period of time for it be a sustainable project. In order to achieve this, the building must be constructed to a good standard and strong materials must be constructed to minimize the effects of damage.

These are the possible Materials we have researched for this project, and are the ones we have rejected:

<table>
<thead>
<tr>
<th>Walls</th>
<th>Explanation</th>
<th>Roofing</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rammed Earth Walls</td>
<td>Is a simple method which is similar to Compressed and Stabilized Earth Blocks; however the technique is a bit harder.</td>
<td>Steel Reinforcing</td>
<td>Steel is very expensive and is very bad for the environment. It would be illogical to chose steel in any construction aspect in Devikulam.</td>
</tr>
<tr>
<td>Standard Burnt Bricks</td>
<td>Standard burnt bricks, as seen in the Devikulam houses, are easily weathered thus are more susceptible to damage, thus leading to a very weak brick.</td>
<td>Thatched Palm / Palmyra Leaf</td>
<td>This roofing does not provide enough shelter from the weather as it can let in the rain.</td>
</tr>
<tr>
<td>Concrete Walls</td>
<td>Concrete walls do provide good protection however transportation and cost could be an issue.</td>
<td>Bamboo Palmyra and Ferro cement Composite Roofing</td>
<td>Bamboo is a much better substitute however the cost of the cement / concrete is too high. This option was almost chosen.</td>
</tr>
<tr>
<td>Bamboo Reinforced</td>
<td>An improvement on standard concrete walls. Again cost and transportation issues limit the concretes chances.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This brings us to our chosen materials for the foundations, walls and roofing:

- Foundations - Bamboo Reinforced Concrete
- Walls - Compressed and Stabilized Earth Blocks (CSEB’s)
- Roofing - Bamboo Palmyra and Ferro Cement Composite Roofing
Foundations

As Devikulam is in an area which is subject to hurricanes flooding and earthquakes, foundations must be strong and able to hold the building off ground level. Concrete foundations reinforced with bamboo are the most suitable option for the Complex. The combined compressive and tensile strengths of concrete (50MPa) and bamboo (350-500 MPa) respectively should uphold the complex without fail. A concrete slab will be placed over the foundations which will make up the floor of the complex.

Walls

The most appropriate material for the construction of the walls are the Compressed and Stabilized Earth Blocks (CSEB’s). With the Multipurpose complex, the walls need to be extremely strong leaving no chance of failure as it will be a well used facility. The most essential benefit of the CSEB is the improved compressive strength it gives (Auroville Earth Institute, 2011). Without a strong material the complex would be unable to last for a significant period of time. This material would be useless if it wasn’t sustainable for the community however much evidence shows the SCEB’s can be made by the local community. It utilizes local raw earth combined along with the Auram 3000 Earth Press to produce the high quality brick; minimal cement can also be added to the mixture to achieve higher strengths (Auroville Earth Institute, 2011). Another minor benefit is the thermal mass, which addresses the heat issue the people face in the summer time; the bricks resist the rise in temperature (Auroville Earth Institute, 2011).

To construction process requires 6-10 people to operate with only 1 skilled worker (Auroville Earth Institute, 2011). The Auram 3000 is the most essential tool which compact’s the bricks, giving it its heightened strengths, opposed to the standard bricks.

Overall the CSEB’s provide great protection from the weather and are very durable. They are simple to construct and are more overall aesthetically appealing than normal standard burnt bricks.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auram 3000</td>
<td>$1400-$2200</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>$26 / m^3</td>
<td>6</td>
</tr>
<tr>
<td>Aggregate</td>
<td>$40-$55 / m^3</td>
<td>3.5</td>
</tr>
<tr>
<td>Cement</td>
<td>$64 / m^3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

(Nazir, 2010), (USA Gardener, 2010), (Galt Technology, 2011)
Calculations for CSEB

Dimension of CSEB: Width: 110mm  Length: 230mm  Height: 80mm

**Building 1** 10m width x 15m length x 2.5m height

\[
\begin{align*}
\text{Bricks high} & = \frac{2.5}{0.08} = 32 \text{ bricks high} \\
\text{Bricks length} & = \frac{10}{0.23} = 65 \text{ bricks length} \\
\text{Bricks width} & = \frac{15}{0.23} = 43 \text{ bricks width.}
\end{align*}
\]

\[2 \times 32 \times 65 + 2 \times 32 \times 43 = 6912 \text{ bricks}\]

**Building 2** 8m width x 8m length x 2.5m height

\[
\begin{align*}
\text{Bricks high} & = \frac{2.2}{0.08} = 32 \text{ bricks high} \\
\text{Bricks length} & = \frac{8}{0.23} = 35 \text{ bricks length} \\
\text{Bricks width} & = \frac{8}{0.23} = 35 \text{ bricks width.}
\end{align*}
\]

\[2 \times 32 \times 35 + 2 \times 32 \times 35 = 4480 \text{ bricks}\]

**TOTAL** = 11500 bricks

<table>
<thead>
<tr>
<th>Component</th>
<th>Ratio</th>
<th>Price m^3</th>
<th>Bricks per component</th>
<th>Brick Vol m^3</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>6</td>
<td>$26</td>
<td>6900</td>
<td>0.002024 m^3</td>
<td>$363</td>
</tr>
<tr>
<td>Sand / Aggregate</td>
<td>3.5</td>
<td>$40-$55</td>
<td>4025</td>
<td>0.002024 m^3</td>
<td>$407</td>
</tr>
<tr>
<td>Cement</td>
<td>0.5</td>
<td>$64</td>
<td>575</td>
<td>0.002024 m^3</td>
<td>$75</td>
</tr>
</tbody>
</table>

**Roofing**

Roofing is a major issue for the people of Devikulam. Protection from the weather is a key factor in the aid to raise the quality of life within the community. Currently their most abundant source for roofing material is the thatched palm and Palmyra leafs. Obviously they don’t protect their current buildings from the intense rain which presents in the wet season; therefore is not suitable for the high quality multipurpose centre.

Innovative thinking must come into play, to maximize the overall sustainability. Therefore, we have chosen corrugated tin sheets to be placed over the multipurpose complex. Not only is this much cheaper than Ferro cement (Colorbond Roofing), it helps with the runoff of water being channelled into the water tank. To avoid rust a galvanized zinc coating must be applied over the tin which is a fairly used technique with corrugated tin roofing (Colorbond Roofing).

The roofing needs to be placed on a slight angle so the water can runoff into the gutters, thereon into the water tank.

Timber beams and Purlins are needed to be placed across the top of the CSEB’s so that the roof can be safely supported.

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
<th>Amount</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tin Roofing</td>
<td>$20 / M^2</td>
<td>215m^2</td>
<td>$4300</td>
</tr>
</tbody>
</table>

*(BlueScope Steel, 2010)*
Conclusion

Through the use of this multipurpose complex we are aiming to raise the standard of living within the poor community of Devikulam. However, the major issue in this project is the money which is needed to buy the materials. We have chosen what we think are the cheapest and most sustainable materials for the community, in order to improve the quality of life. These materials are the CSEB’s used for the walls and the corrugated steel used for the roofing. The quality of the complex has to be the best in order to provide good protection from the weather and to be sustainable for the years to come. With these materials it is possible for the multipurpose to be a sustainable investment for the community.

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
<th>Amount</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSEB</td>
<td>Working shown Above</td>
<td>11500 bricks</td>
<td>$845</td>
</tr>
<tr>
<td>Tin Roofing</td>
<td>$20 / M^2</td>
<td>215m^2</td>
<td>$4300</td>
</tr>
<tr>
<td>Auram 3000</td>
<td>$1400 - $2200</td>
<td>1</td>
<td>$1400 - $2200</td>
</tr>
</tbody>
</table>

Costing

Building Supplies

<table>
<thead>
<tr>
<th>Item / Material</th>
<th>Quantity</th>
<th>Cost Per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auram Compressed Earth Block Maker</td>
<td>3,000</td>
<td>2</td>
<td>$1,400 - $2,200</td>
</tr>
<tr>
<td>Soil (for 11,500 bricks)</td>
<td>14m³</td>
<td>$26 per m³</td>
<td>$365</td>
</tr>
<tr>
<td>Sand/Aggregate (for 11,500 bricks)</td>
<td>8m³</td>
<td>$45 per m³</td>
<td>$360</td>
</tr>
<tr>
<td>Cement (for 11,500 bricks)</td>
<td>1.2m³</td>
<td>$64 per m³</td>
<td>$77</td>
</tr>
<tr>
<td>Tin Roofing</td>
<td>215m²</td>
<td>$25 per m²</td>
<td>$5,400</td>
</tr>
<tr>
<td>Water Tank (inc. fittings, plumbing)</td>
<td>1</td>
<td>$1,000 - $2,000</td>
<td>$1,000 - $2,000</td>
</tr>
<tr>
<td>Solar Panels</td>
<td></td>
<td></td>
<td>$10,000-$15,000</td>
</tr>
<tr>
<td>Concrete for Slab</td>
<td>18m³</td>
<td>$200 per m³</td>
<td>$3,600</td>
</tr>
<tr>
<td>Guttering</td>
<td>82m</td>
<td>$30 per m</td>
<td>$2,500</td>
</tr>
<tr>
<td>Doors</td>
<td>3</td>
<td>$200</td>
<td>$600</td>
</tr>
<tr>
<td>Windows</td>
<td>8</td>
<td>$195</td>
<td>$1,560</td>
</tr>
<tr>
<td>Skylights</td>
<td>2</td>
<td>$400</td>
<td>$800</td>
</tr>
</tbody>
</table>

School Fittings

<table>
<thead>
<tr>
<th>Item / Material</th>
<th>Quantity</th>
<th>Cost Per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Chairs</td>
<td>40</td>
<td>$14</td>
<td>$560</td>
</tr>
<tr>
<td>School Desks</td>
<td>20</td>
<td>$40</td>
<td>$800</td>
</tr>
<tr>
<td>Blackboard</td>
<td>2</td>
<td>$200</td>
<td>$400</td>
</tr>
<tr>
<td>Stationary</td>
<td>-</td>
<td>-</td>
<td>$200</td>
</tr>
</tbody>
</table>

(Nextag, 2011)

Fittings for Health Centre

<table>
<thead>
<tr>
<th>Item / Material</th>
<th>Quantity</th>
<th>Cost Per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3m Straight curtain</td>
<td>4</td>
<td>$33</td>
<td>$132</td>
</tr>
<tr>
<td>tracking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4m Straight curtain</td>
<td>3</td>
<td>$26</td>
<td>$78</td>
</tr>
<tr>
<td>tracking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8m Straight curtain</td>
<td>2</td>
<td>$20</td>
<td>$40</td>
</tr>
<tr>
<td>tracking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90° tracking turn</td>
<td>4</td>
<td>$18</td>
<td>$72</td>
</tr>
<tr>
<td>Curtain ‘Carrier’</td>
<td>80</td>
<td>$2</td>
<td>$160</td>
</tr>
<tr>
<td>Track joint</td>
<td>10</td>
<td>$2</td>
<td>$20</td>
</tr>
<tr>
<td>End stop</td>
<td>8</td>
<td>$2</td>
<td>$18</td>
</tr>
<tr>
<td>Curtain</td>
<td>4</td>
<td>$40</td>
<td>$120</td>
</tr>
<tr>
<td>Bed</td>
<td>2</td>
<td>$200</td>
<td>$400</td>
</tr>
<tr>
<td>Medical Equipment</td>
<td>-</td>
<td>-</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

(All Partitions, 2011)

Labour:

The average minimum wage in India is around 117 rupees per day for construction workers (Paycheck India, 2010) this is roughly equivalent to $2.4 per worker per day of work. We, working for Engineers Without Borders, realise that this is very low pay, and believe it is unethical to make someone work for such a low cost per day. This is only the minimum legal wage and depending on circumstance, most employers in India will pay their workers around 35% more than this legal minimum. This would raise the average pay for unskilled labour to 160 rupee a day, or $3.3 Australian Dollars (India Pakistan Trade Unit, 2010). We still believe that this is an unreasonably low wage to be paid for the hard work that will be done by the workers in constructing this health and education centre. For this reason we have decided to pay our workers twice the minimum wage per day, that means they will receive 234 rupee a day, or the equivalent to $4.7 AUD per day. This may still seem like a low price, but because of the low pay in India, the cost of living is below that of Australia, meaning they do not need equivalent pay to those in Australia. This pay of 234 rupee will mean they are receiving well above the average salary and will be able to use the money to buy decent food and produce, the pay, is at the same time, considerably below what would have to be paid to Australian labour workers, allowing the construction to be completed at the lowest possible cost while maintaining a good standard of ethics.

Some local semi-skilled labourers will be required for the construction of this health and medical centre. These semi-skilled workers will be employed to do the jobs that require slightly more training than construction, or need some background knowledge. These jobs would include operation of the Auram 3,000 compressed earth block making machines, as well as installation of solar panels and electrical wiring to the medical centre and installation and plumbing of the water tank. The minimum wage of a semi-skilled labourer is 141 rupee a day, around $2.9 AUD per day (Paycheck
India, 2010). We will also pay these semi-skilled labourers twice what they are entitled to as their minimum wage, raising this cost to 282 rupee a day, $5.8 AUD. We will need three semi-skilled labourers to work the two Auram 3,000 machines, having one extra trained worker will allow the other two to take breaks. We will also need a further three to install solar panels and do the electrical work, and another three to install the water tank and plumbing for it.

<table>
<thead>
<tr>
<th>Level of Skill</th>
<th>Number of Workers</th>
<th>Cost per day of worker</th>
<th>Total cost per day</th>
<th>Days Required</th>
<th>Total cost for skill level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-Skilled Local(Auram 3,000 workers)</td>
<td>3</td>
<td>$5.8 AUD</td>
<td>$17.4</td>
<td>1</td>
<td>$261</td>
</tr>
<tr>
<td>Semi-Skilled Local(electricians)</td>
<td>3</td>
<td>$5.8 AUD</td>
<td>$17.4</td>
<td>5</td>
<td>$87</td>
</tr>
<tr>
<td>Semi-Skilled Local(plumbers)</td>
<td>3</td>
<td>$5.8 AUD</td>
<td>$17.4</td>
<td>2</td>
<td>$35</td>
</tr>
<tr>
<td>Unskilled Local (Clearing Land)</td>
<td>2</td>
<td>$4.7</td>
<td>$9.4</td>
<td>2</td>
<td>$18.8</td>
</tr>
<tr>
<td>Unskilled Local (Excavation, slab prep.)</td>
<td>4</td>
<td>$4.7</td>
<td>$18.8</td>
<td>5</td>
<td>$94</td>
</tr>
<tr>
<td>Unskilled Local (Slab pouring)</td>
<td>6</td>
<td>$4.7</td>
<td>$28.2</td>
<td>1</td>
<td>$28.2</td>
</tr>
<tr>
<td>Unskilled Local (Frame Construction)</td>
<td>5</td>
<td>$4.7</td>
<td>$23.5</td>
<td>5</td>
<td>$117.5</td>
</tr>
<tr>
<td>Unskilled Local (Walls)</td>
<td>15</td>
<td>$4.7</td>
<td>70.5</td>
<td>3</td>
<td>$211.5</td>
</tr>
<tr>
<td>Unskilled Local (Doors, windows, trim)</td>
<td>4</td>
<td>$4.7</td>
<td>$18.8</td>
<td>2</td>
<td>$75.2</td>
</tr>
<tr>
<td>Unskilled Local (Fittings)</td>
<td>4</td>
<td>$4.7</td>
<td>$18.8</td>
<td>5</td>
<td>$75.2</td>
</tr>
<tr>
<td>Unskilled Local (Landscaping, finishing)</td>
<td>4</td>
<td>$4.7</td>
<td>$18.8</td>
<td>5</td>
<td>$75.2</td>
</tr>
</tbody>
</table>

**Total Cost:**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Supplies</td>
<td>$29,062 - $34,862</td>
</tr>
<tr>
<td>School Fittings</td>
<td>$1,960</td>
</tr>
<tr>
<td>Health Centre Fittings</td>
<td>$3,040</td>
</tr>
<tr>
<td>Labour</td>
<td>$1,078.60</td>
</tr>
<tr>
<td>Extra (in case of any issues)</td>
<td>$2,000</td>
</tr>
<tr>
<td><strong>TOTAL COST</strong></td>
<td><strong>$43,000</strong></td>
</tr>
</tbody>
</table>
Funding Plan

The cost of materials and labour to implement and construct this health and education centre in Devikulam is clearly too much for the people of Devikulam to fund, and at around $43,000 AUD it is too much to expect Engineers Without Borders to solely fund. For this reason we will have to come up with an innovative way to raise that $43,000 to implement the health and education centre. After talking to our good friends in the Cambodian Kids Foundation, a locally started foundation focused on improving the quality of life for children in Soksan village, Cambodia, who have raised around $300,000 AUD in the last two years, and opened two schools, it was realised that our main focus for funding would have to take place in the local community (Cooper, 2011). Our group has the benefit of having three members from the same small country town, Gisborne. The sense of community is high in small country towns like Gisborne, and people are willing to help out the other locals in the area, for this reason we will focus the early part of our funding scheme on generating funds in Gisborne. Our funding scheme will start with small efforts to raise small amounts of money, but generate interest in our project, and then increase in size to larger donations or events once our cause is more well known and the local community sees us as more developed.

Step One: Local BBQs

We will begin our efforts of fundraising by setting up small barbeques at the local town market in Gisborne every Sunday. This will earn some small profits, but mainly it will make us and our cause known in the community. We will do this for two weeks, before using the profits from those BBQs to have pamphlets printed. These pamphlets are attached to this report as Appendix One

Once we have been established we will move onto having a BBQ at a Bunnings Warehouse store such as Caroline springs. Here we will get significantly more customers, and will be able to hand out our pamphlets to customers, which will further improve how well we are known and our cause is known as well as entice some donations.

BBQs will continue after these initial 3 weeks, however we will begin to implement other stages of the funding plan after these initial set up weeks.

Run time: 3 weeks +
Earnings: $900 + a lot of promotion for our cause, donations in the future.

Future BBQs, will run on campus at RMIT, we expect to hold three or four of these on campus BBQs, we will continue to hand out pamphlets at these and we will try to find butchers who will donate sausages to a good cause.

Run time: 4 BBQs
Earnings: $700 per day = $2,100 total

Step Two: Wrist Bands

Once we are established we will have some rubber wrist bands made, which we will sell for $3 each. Based on the cost of $1 each to buy from a supplier we should be making $2 per wrist band sold as well as a lot of promotion. It is very common for people to ask their friends what their wrist band says, and this will help us with promotion, and sales of wrist bands. Over four months we expect we could sell 4,000 wrist bands, if they are sold on campus at RMIT, at our BBQs, and in local businesses in Gisborne and other small towns who are willing to help a good cause.

Run time: 4 Months
Earnings: $8,000
Step Three: Donation Tins
Once our wrist bands have been made and are being sold we plan to introduce small donation tins to make a small amount of money. We will go around local businesses and request them to place the tin on their counter, near their registers for the next four months. We expect that around five businesses will do this. We will try to get as many cafes as possible to introduce the tins because it is very common for a person to buy a coffee from a $5 note, then receive just over a dollar change, which is often put into a donation tin if there is one available.

Run time: 4 Months
Earnings: $3,000

Step Four: Raffles
Raffles will be started at the same time as the wrist bands will be implemented. It is thought that after our three weeks of BBQs we will have made a name for ourselves enough in Gisborne to begin selling raffle tickets. For the first few raffles we hold we will have to buy the prizes trying to keep them at around $50 and selling tickets for $1.50. Once we have held one or two raffles we will be able to approach local businesses and ask for donations for us to raffle off. This will work both for us and them because they will be getting promotion from the raffle and we will be earning money without having to spend much.

Run time: at all BBQs
Earnings: $2,000

Step Five: Sponsorships
One month after beginning the wrist band sales, we will begin to ask around local businesses in Gisborne and surrounding towns for possible sponsorships. If we are able to secure any sponsorship we will be able to hold an entertainment night where we will combine all aspects of our funding plan to try to put a large dint in the total we have to raise. We expect to be able to get 3 sponsorships per entertainment night, which would provide us with a raffle from that organisation, as well as thanking them both at the beginning and ending on the night. We would hope to make around $1,500 off these sponsorships along with a raffle basket.

Run time: Twice, before each ‘Entertainment Night’
Earnings: $ 9,000 + $2,000 (raffle tickets)

Step Six: Entertainment nights
We plan to hold two entertainment nights to help fund our project. The first night will be held two months after we begin selling the wrist bands, and the second will take place four months after we first start selling wrist bands. These nights will take place at venues such as Hesket House in Woodend, which are comfortable, warm and give a good atmosphere. They will be aimed at providing those who come a fun a warm night where they get to meet us, and are updated on our progress with the fundraising and how we are progressing through the project. These nights are expected to draw around 70 people to each, these people would be the people most likely to donate to our cause and the people most interested in helping us make a change. Tickets for these events will be sold for $50 each.

Funds will not only be raised from entry fees, we will also have raffles of goods donated by local businesses and a silent auction on other donated goods we can have donated by local businesses, along with a series of 5 photos taken by a local photographer, Jack Cooper, who is willing to donate some photos.

Run time: Two events over 4 months
Earnings: $7,000 ticket sales
$4,000 silent auction
Step Seven: Donations
We expect to receive some monetary donations from some people who attend our entertainment nights along with some other people who have read our pamphlet that is handed out at the BBQs, this amount is expected to be maybe around 15 people donating a total of $5,000. We hope to receive some monetary donations from local businesses as well that will also total around $5,000 from around 5 businesses.
  Run time: 4 Months (from when pamphlets are made available)
  Earnings: $10,000

Totals:
  Run Time – 5 months
  Earnings - $48,000
Our projections show we will earn $5000 more than we need for the project to go ahead, however it is good that the projection shows us getting more than we need, because if any aspect of the funding plan doesn’t work how we plan for it to, we have a little bit of a buffer and it means everything does not have to work 100% to plan.
References:


Cooper, J. (2011, 10 8). (M. Power, Interviewer) Melbourne, Victoria, Australia.


India Employment Law. (2010, July). Retrieved 10 7, 2011, from India Pakistan Trade Unit: http://www.iptu.co.uk/content/india_employment_law.asp#9

India Pakistan Trade Unit. (2010, July). Employment Law. Retrieved October 8, 2011, from India Pakistan Trade Unit: http://www.iptu.co.uk/content/india_employment_law.asp#9


Team Duties

**Josh Clough**

Josh initially completed the Assignment 1 on Materials so was able to assist in the choice of materials used in the construction. During the initial discussion and brainstorm of ideas Josh was able to help come up with the three ideas contained within the intermediate report. Within the group Josh was paired with George Street to develop the Option 3 of the intermediate report, the ‘Multi-purpose Centre’. Within this section Josh assisted in the creating the layout of the centre whilst proposing the most effective materials to be used. Further on from this Josh created the design for the centre, drawing in AutoCAD to give an aesthetically pleasing demonstration of our ideas to accompany the explanations. Josh also researched and assessed the role of the water tank in the design to ensure it was applicable and what products should be used.

**Taylor Crameri**

Taylor investigated buildings within Devikulam before the commencement of this major assignment; he brought this knowledge to the group and used it to assist whenever it was needed. He was paired with Matt to undertake research for the design option two in the intermediate report. Together they investigated the transport issues within Devikulam. For both the intermediate and final report Taylor undertook the job of publication, editing and collating everyone’s final work into one consistent final report. Additionally he researched the climate and location of Devikulam and completed the scope for the final report.

**Max McCardel**

Max investigated the climate and seasonal conditions of the Devikulam society, and discussed how this would affect the overall design and construction of the buildings. Furthermore, Max explored the possible sustainability solutions available to the community and explained the importance of designing sustainable solutions. As well as this, Max examined how the centre will be used and how this will benefit the town and investigated some of the costing of such facilities.

**Matt Power**

Matt and Taylor were paired together at the beginning of the intermediate report to investigate transport issues in Devikulam and propose a solution to these issues, which would become the second design option. During this intermediate report Matt also wrote up the criteria that would be used in order to determine which option would be chosen to elaborate on in the final report. For the final report Matt took on several aspects of the report, he covered the chosen option justification and re-rating of the chosen option. He went on to research and discuss the social benefits of the centre, including benefits associated with the markets and education centre. The costing section was also put together by Matt, however for this section he received some costing aspects from other members, Josh had done the costing for the water tank and plumbing, and Luke determined how much materials we needed for bricks, George also helped by providing timetables of how long we needed labourers for. Matt’s final section was the funding scheme in which he determined a way to raise the necessary funds within 5 months.
George Street

George’s first research assignment was on Devikulam’s current infrastructure and utilities, and ways that they could be improved, which assisted in the discussion on which areas of community’s standard of living needed most improvement. When in the initial brainstorming stage of the major assignment George contributed well to group discussion putting forward ideas and helped communicate these ideas to our tutor. Within the group George was paired with Josh to develop and research option 3, the ‘Multi-Purpose Centre.’ Individually, George came up with initial concept design drawing, and researched and discussed what specific utilities and attributes that could be included (such as the medical centre, toilet block, solar panels etc) in the centre for the presentation and intermediate report. In the final write-up George wrote a building schedule, and constructed a Gantt chart to outline the various phases and their various times of completion.

Luke Turner

Luke was in charge of investigating the materials involved with the centre. In the intermediate section, a general overview of materials were covered (design option 1), however the chosen materials were discussed in much more detail for the final report. Luke also discussed how a community consultation plan could be initiated and implemented within Devikulam.

Turnitin

We as a group were relatively happy with our turn in it in percentage of 2%, well below the 5% threshold. We believe this means everyone adequately researched their delegated tasks rather than just copying someone else’s work. This is a good benchmark to aim for in our future projects. The turnitin percentage ensures that we cannot be falsely accused of plagiarism.
How You Can Help

With our proposal costing around $45,000AUD we cannot expect the people of Devikulam to fund the project, nor can Engineers Without Borders. There is a range of ways you can support our cause and help our fundraising:

- Buy a sausage when you see us set up
- Buy a wristband off us for just $3
- Support our raffles
- Attend our entertainment nights
- Spread the word!

And of course, all DONATIONS are welcome

If you would like to know any more about our work, or our progress, please feel free to contact us.
Engineers Without Borders

Engineers Without Borders’ is a not for profit organisation which works with Universities to allow students to work on real life issues and develop solutions to these issues. This type of learning is extremely valuable to students in the field of Engineering.

The EWB challenge is aimed at first year students in universities across Australia, it allows first year students to develop solutions to two issues, this is used as an assignment at the university, which then chooses the best assignments to be presented to Engineers Without Borders.

This years EWB challenge focuses on the poor quality of life in Devikulam, a small Indian village where almost the entire population of 360 people live under the poverty line.

What We are Doing

Our groups proposal to Engineers Without Borders is a health and education centre. It was determined after much discussion that implementing this into the village of Devikulam would be the most beneficial way to improve their quality of life. The implementation of this centre will allow an instant improvement in their quality of life as they will have access to education above primary school level, along with access to much needed medical attention. The centre will also help teach the students life skills and trades that will allow them to become the future of Devikulam and keep moving in the right direction, it will provide them with the tools to develop by themselves. The proposal also incorporates a public space to be used for fortnightly or monthly farmers markets. This will bring with it large social benefits, for the town as there is currently some resentment between financial classes.

To minimise stress on the local community the centre is completely self sustainable, being fitted with solar panels to combat the common power outages in the area, and a water tank to service only the medical centre.

What it Will Cost

Implementation of this proposal will cost around $45,000 AUD, this includes labour costs, material costs and machinery costs.

A cost breakdown is in table below:

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Supplies</td>
<td>$29,062 - $34,862</td>
</tr>
<tr>
<td>School Fittings</td>
<td>$1,960</td>
</tr>
<tr>
<td>Health Centre Fittings</td>
<td>$3,040</td>
</tr>
<tr>
<td>Labor</td>
<td>$2,000</td>
</tr>
<tr>
<td>Extra (in case of any issues)</td>
<td>$2,000</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>$44,000</td>
</tr>
</tbody>
</table>