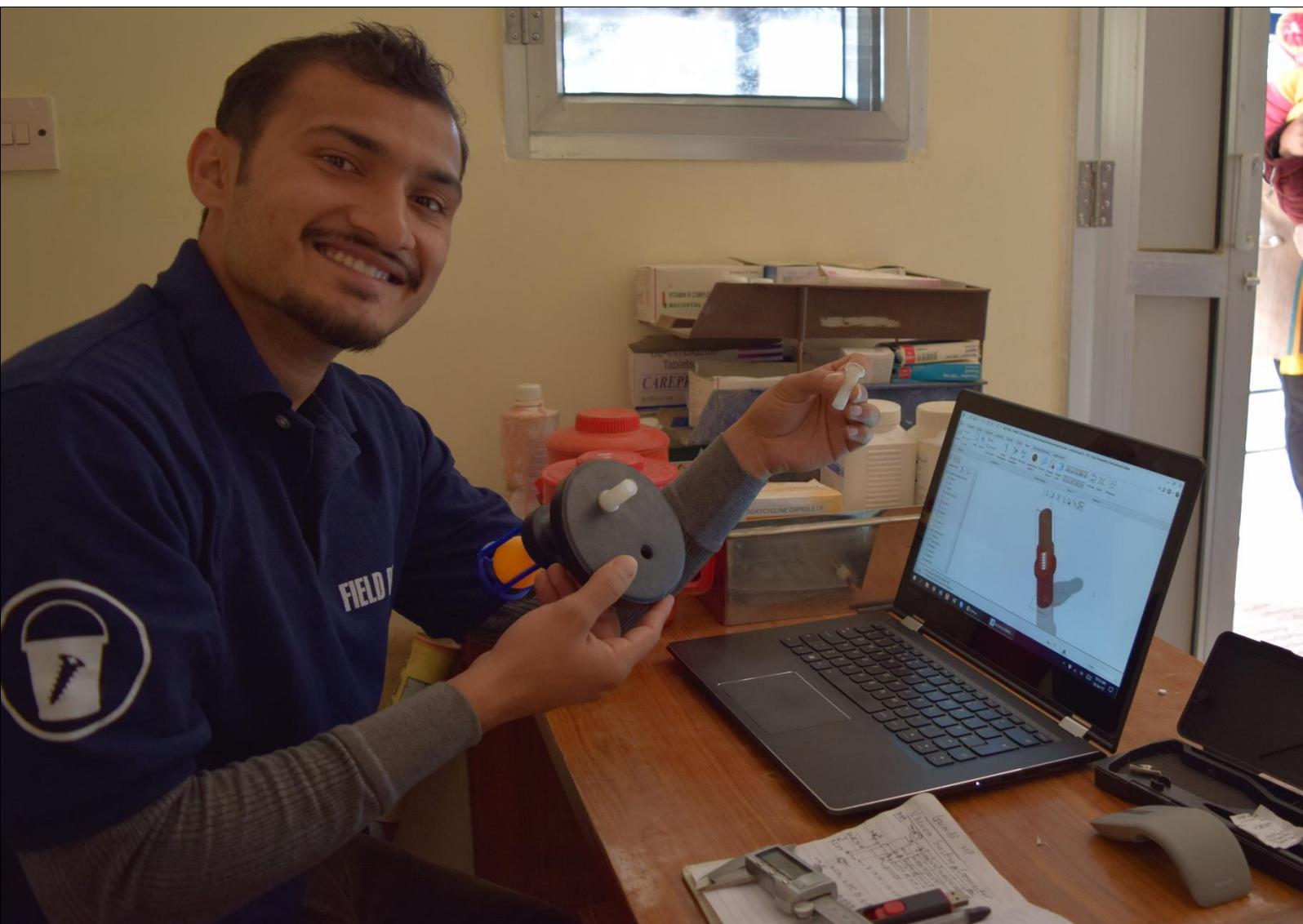


Cost-Effective Manufacturing in the Field

An economic study of Field Ready's work in Nepal



Purpose

Field Ready has put together of documents, called Technical Papers, on a variety of issues and topics that relate to our work. These serve as “white papers” to clarify our approach, form the basis of policy, elucidate challenging subjects and serve as one of several ways we lend thought leadership to our sector.

Specific Purpose of this Technical Paper

The purpose of this Technical Paper #2 is to share the key findings of an in-depth study undertaken by Dan Butler (MEL lead at Field Ready) and Anna Lowe (independent supply chain specialist) in Nepal in 2017.

Contents

	<i>Page</i>
1. Summary	1
2. Background	2
3. Data Gathered	3
4. Time and Logistical Bottlenecks	5
5. Comparing Costs	8
6. Local and International Merchants	12
7. Conclusions	15
8. Appendix: Full Cost Calculations	17

1. Overview

This paper compares the cost of essential relief items manufactured by Field Ready in Nepal with the best available alternatives.

Local manufacturing of aid supplies – using both high-tech and low-tech methods – provides an opportunity to create business models that can realise substantial cost savings compared to conventional procurement of finished products via international supply chains.

Our analysis showed that items locally manufactured by Field Ready realise cost savings of **up to 90%**:

Fetoscope: *A simple, re-usable medical device*

The cost of manufacturing is marginally higher than buying an imported item in Kathmandu. However, if it can be produced in the field in remote areas through a fixed or mobile capability, then the overall cost can be lower.

Otoscope: *A more complex medical device*

The cost of manufacturing is 75% lower than the cost of buying an imported item. The item can also be maintained more easily, using locally available parts.

Cookstove knobs: *Spare part for a high value device*

The cost of manufacturing is similar to the cost of buying and shipping replacements from the manufacturer. However, in a situation where the normal supply chain had been completely disrupted a costly delay could be avoided.

Vacuum pump part: *Spare part for a high value device*

The cost of manufacturing is 90% lower than buying replacement parts, which can be difficult or impossible to source through conventional means.

Aid agency staff we interviewed indicated that **there is demand** for locally manufactured relief supplies. However, they also raised concerns that in their experience there is rarely the capacity within local markets to deliver quality items consistently.

We also spoke to local and international merchants and, whilst in theory some merchants would lose out if aid agencies bought more items locally, they saw a number of potential benefits. Individual merchants saw potential opportunities to supply new items to their customers, or to deliver value in new ways.

To raise interest in supporting the local manufacturing of essential relief supplies, aid agencies and donors suggested to us that there is a need for more evidence to help them to understand how the approach can produce value for money over the medium and long term.

Field Ready will use this analysis as the basis for further economic modelling and to inform strategies for developing the capacity of local businesses and NGOs to manufacture essential relief supplies when and where they are needed, saving money, time and lives.

2. Background

The purpose of this paper is to share data gathered by Field Ready to begin to understand the time, cost and risks implications of manufacturing essential relief items in the field, when and where they are needed.

The original brief set out three questions for the research to address:

- Q1. How do considerations such as time and logistical bottle-necks impact the provision of key items?
- Q2. What are the direct and indirect (“tooth to tail”) costs of comparable relief items?
- Q3. How might introducing manufacturing at the field level impact local and international merchants?

Field Ready’s work addresses immediate humanitarian needs by transforming logistics through technology, innovative design and engaging people in new ways. Field Ready brings manufacturing to challenging places, using the latest technology as well as traditional machines and appropriate tools. Field Ready works with a wide range of partners, and provides training for others to solve problems locally in areas such as health, shelter and WASH (water, sanitation and hygiene).

Following the April 2015 earthquake in Nepal, Field Ready conducted on-the-ground assessments and began working with several partners to staff an Innovation Lab in Kathmandu. Field Ready are training and equipping aid agencies, local maker spaces and local entrepreneurs to enable them to manufacture essential relief supplies when and where they are needed.

This paper gathers and analyses data in relation to Field Ready’s work in Nepal, to consider the learning that may have relevance beyond this particular case, and to inform decision-making and strategic planning.



Manufacturing in remote areas of Nepal using portable equipment powered by car battery.

3. Data Gathered

To produce this paper, we completed a desk-based review of relevant documentation and conducted in depth interviews with individuals representing different stakeholders in the provision of relief items in Nepal. The table opposite provides a description of the interviewees and their relationship to Field Ready's work.

We selected a list of the items that Field Ready has manufactured in Nepal for the focus of this study. We initially focussed on those items which had reached a more advanced stage of development, so that their cost of production could be compared. From amongst the more fully developed items, we then identified a varied selection, with different types of products and different levels of complexity. The table below provides a description of the final list of items investigated.

Table 1: A selection of items manufactured by Field Ready in Nepal, as included in this study

	Item	Category
i.	Fetoscope	A1. New whole products – simple
ii.	Otoscope	A2. New whole products – complex
iii.	Replacement cookstove knobs	B. Spare parts for equipment
iv.	Vacuum pump part	B. Spare parts for equipment
v.	Improved cookstove air supply disc	C. Digital fabrication of mould for casting

Based on the information gathered, both in documentation and through the interviews, we have analysed the cost of manufacturing those items in the field compared to procuring them through normal means on the local or international markets.

The following sections address the three questions from the brief, in turn.

Table 2: Key stakeholders interviewed and their relationship to Field Ready's work

	Role	Organisation	Relevant items	Relationship to Field Ready's work
A.	Senior manager, Agency A	Agency A – an international NGO	i. Fetoscope	Agency A commissioned and distributed items manufactured by Field Ready.
B.	Supply chain analyst, Agency A		ii. Otoscope	
C.	Health manager (former), Agency A		iii. Replacement cookstove knobs	
D.	Senior manager, Agency B	Agency B – an international NGO	N/A	Agency B has been supported the prototyping and development of water/sanitation supplies manufactured by Field Ready.
E.	Programme manager, Agency B			
F.	Logistics coordinator, Agency B			
G.	WASH coordinator, Agency B			
H.	Manager	Government health post in rural district	i. Fetoscope ii. Otoscope iv. Vacuum pump spare part	The health post has received items manufactured by Field Ready.
J.	Senior manager	Major donor	All items	The donor is supporting Field Ready to test and demonstrate local manufacturing of humanitarian items in Nepal.
K.	Managing director	Local merchant – medical wholesaler	i. Fetoscope ii. Otoscope iv. Vacuum pump spare part	The manager has provided informal advice, in a personal capacity, to assist with the development of medical items by Field Ready.
L.	Operational director	International merchant – cookstove supplier	iii. Replacement cookstove knobs v. Improved cookstove air supply disc	The company was the original supplier of the cookstoves for which Field Ready manufactured replacement knobs. They are also a competitor to local cookstove manufacturers.

Q1. How do considerations such as time and logistical bottlenecks impact the provision of key relief items?

This section describes examples of the time and logistical bottlenecks that Field Ready seeks to address through local manufacturing of aid supplies. It is based both on the specific items that Field Ready has manufactured in Nepal and the broader context as described by the people interviewed for this study.

Nepal earthquakes 2015

During the emergency the government regulation was quite complicated in terms of bringing stock in, then got better, then we had the blockade [of the border with India]. Work was never suspended, we had issues moving vehicles but we had stock in place by then, we had developed good relationships with the relevant officials. We underspent as we slowed, even when flying in goods rather than trucking them in was adding to costs. -Senior manager, Agency B (INGO)

Many common themes emerged from our interviews with aid agency and government staff about the time and logistical challenges they faced – access to accurate information about needs, the remoteness of some of the locations requiring relief, and the pressures on staff capacity.

In the early stages of the response to the Nepal earthquake, aid agencies told us that it took time to develop a good working relationship with the government and that at times this was the biggest challenge they faced. Agencies told us that managing the distribution of supplies involved complex negotiations with government officials, particularly during times of political tension.

In Nepal, aid agencies are prohibited from importing anything that costs more than \$200, with the expectation that agencies should work with authorised local importers to supply items they need. Items imported by INGOs in Nepal are also subject to a 101% import tax. Immediately following the earthquake, the Nepali government waived these restrictions but only for three months, at which point many agencies were still engaged in the mass import and distribution of essential items.



The remoteness of locations where assistance was needed presented severe logistical challenges.

As the response progressed, Nepal experienced seismic aftershocks, extreme weather events and political instability, all of which created additional time pressures. One of the aid agency staff we interviewed told us that the blockade of the border with India created logistical bottlenecks that delayed the delivery of their programmes by between three and five months, depending on the sector.

Normally in a rapid onset natural disaster you'd do a post disaster needs assessment, coordinated by UNOCHA and involving the government and large NGOs but in Nepal the government did their own assessment and that's the data we had to go off. Then you get feedback when you start to do the surveys and post-distribution monitoring and try to triangulate with that... We still have stock in our warehouses. We order to our best estimate but it doesn't ever go to waste – we had some left over tarpaulins and corrugated iron sheets [for shelter] which we were able to distribute when landslides during the monsoon damaged people's homes. -Senior manager, Agency A (INGO)

The relief efforts take place in the context of chronic shortages of supplies. The government health post manager we spoke to described the routine rationing of medical supplies – that it was commonplace for a request made for new items to be only partially fulfilled. Lead times for the supply of new items were erratic, dependent on the availability of stock held centrally by the government, and the availability of vehicles for delivery.

Although the health posts have some budget over which they have discretion, budget allocation from central government for replacement or repair of complex devices was not always available. The health post manager said that if they had additional budget available, they would like to spend it on diagnostic equipment to reduce the time taken for lab testing.

Intervention outcomes

The result is that where time and logistics delay provision of items it impacts outcomes of humanitarian interventions.

We have project deadlines with donors, and we have made commitments to the community and the government. So that makes it hard to renegotiate timing. Also, with crops there are certain times you need to plant. A week's delay can be disastrous. -Procurement manager, Agency A (INGO)

In some cases, the impact of even minor delays can be enormous. In relation to livelihoods programmes, the aid agencies we interviewed explained how incredibly time sensitive agricultural activities like planting and harvesting could be. A delay of as little as one week in the provision of agricultural equipment and inputs could have the potential to lead to severe food shortages in the following months.

Where there are delays or interruptions to the supply of humanitarian relief, those working on the ground may simply improvise solutions. The government health post manager we interviewed described how, for example, if they did not have a medical wrist brace they would use pieces of wood and cardboard instead.

The impacts of time and logistical bottlenecks cause aid agencies to adapt their behaviour. In our interviews with aid agency staff, they explained how they are carefully balancing time against cost and quality to achieve the best outcomes possible for affected populations, by prioritising, negotiating, and constantly adjusting to rapidly changing circumstances.

How local manufacturing can help

The following examples illustrate how Field Ready's approach has helped to address time and logistical challenges through its work.

Example: Medical devices

The earthquake in Nepal destroyed many health posts, the small local clinics providing basic health care. Many NGOs were resupplying health posts with the items that were damaged or destroyed. Until these items are re-supplied, access to basic healthcare is severely reduced. Field Ready was able to contribute to these efforts by manufacturing, amongst other items, tweezers, fetoscopes and otoscopes.

The imported otoscopes that Field Ready examined as part of the design process used bulbs that were not available on the local market. The otoscope designed in Nepal was made entirely from parts that were found to be available locally, allowing them to be more easily maintained at a lower cost.

Field Ready manufactured replacement parts for a vacuum pump (a complex medical device), for the electrical supply unit to a field hospital and a corner piece for a neonatal incubator. Field Ready has since been working with qualified medics to understand how they can be supported to manufacture some of these items for themselves, supported by local Nepali makers with knowledge of the relevant hardware.

Example: Water pipe fittings

Field Ready observed issues with the maintenance of the gravity water feed system in a camp for internally displaced people in a remote area of Nepal. Pipe fittings were inappropriate or improvised, compromising the water quality and risking health problems for those drinking the water.

In response, Field Ready team members were able to design and manufacture replacement fittings on location, and have since been refining the design and building software that would allow others to manufacture the fittings themselves without the need to design from scratch.

Example: Cookstove knobs

A large consignment of cookstoves was received by one of the aid agencies operating in Nepal, to be distributed amongst those living in temporary accommodation in remote rural areas. The provision of the stoves helps to achieve positive health outcomes, by reducing affected people's exposure to smoke from cooking.

There had been some damage in transit of the knobs used to adjust the stoves' airflow. With only a short amount of time before the scheduled distribution, Field Ready was able to manufacture new knobs for the stoves, avoiding the need to wait for the manufacturer to send replacements.

5. Comparing Costs

Q2. What are the direct and indirect (“tooth to tail”) costs of comparable relief items?

The following table provides a headline summary of cost comparisons between items locally manufactured by Field Ready and the best available alternatives we have identified for this study. The cost implications of these differences are described in more detail below and the full cost calculations are included as an appendix.

Table 3: Headline summary of cost comparisons

Item	Landed cost of locally made item	Landed cost of best available alternative	Cost saving of local item over best alternative	Comments on comparability of costed alternatives
Fetoscope	\$3.03	\$2.57	(-18%)	The item is directly comparable.
Otoscope	\$11.48	\$46.31	75%	The item is directly comparable.
Cookstove Knobs (Cost per knob)	\$0.70	\$0.71	(-1%)	Although costed, the alternative introduced more risk against a critical deadline.
Vacuum Pump Part	\$4.33	\$48.54	91%	Alternative spare part requires you to buy more than is needed.
Improved Cookstove Air Supply Disk	\$76.98	-	N/A	No suitable alternative was identified.

- **Category A1. New whole products – simple**

Fetoscope

Cost summary: higher landed cost for Kathmandu but possibly advantageous if provided via mobile manufacturing capacity, or a capacity based in a remote area.

In Nepal, a locally manufactured and reusable fetoscope made in the capital city, Kathmandu, works out slightly more expensive than getting an imported fetoscope into the country. Precise figures are not available as to what the Nepal government supply chain costs are to get a fetoscope from Kathmandu to different rural health posts, but if compared against a fixed (i.e., non-mobile) local manufacturing capability in a town even fairly close to Kathmandu the local manufacturing would almost certainly be cheaper. The price advantage of local manufacturing will increase the further you get from Kathmandu.

More generally, this indicates that local manufacturing can be cost competitive against imported devices when both items are re-usable.

- **Category A2. New whole products – complex**

Otoscope

Cost summary: clear cost advantage, also with lower maintenance costs in the field. Cost of ownership may be higher.

The locally made otoscope is one quarter of the price of an imported item. The comparison listed is against an otoscope imported from Pakistan – a model imported from Germany is available at more than three times the price of those from Pakistan. We understand from the health post that has tested the locally made otoscope that it functions perfectly adequately. Durability would need to be tested in order to evaluate total cost of ownership – if the locally made version lasted less than a quarter as long as the imported version it would end up being more expensive overall. Even if that were the case, where the upfront cost is prohibiting health facilities from having the equipment, having access to a cheaper version could be of benefit.

It is difficult to generalise from this example to say that other more complex medical devices could also be made cheaply locally, but it is certainly an area that could be explored further.



Local medical staff testing Field Ready's locally manufactured otoscope.

- ***Category B. Spare parts for equipment***

Cookstove knobs

Cost summary: costs are similar but local manufacturing provides a clear time/risk advantage.

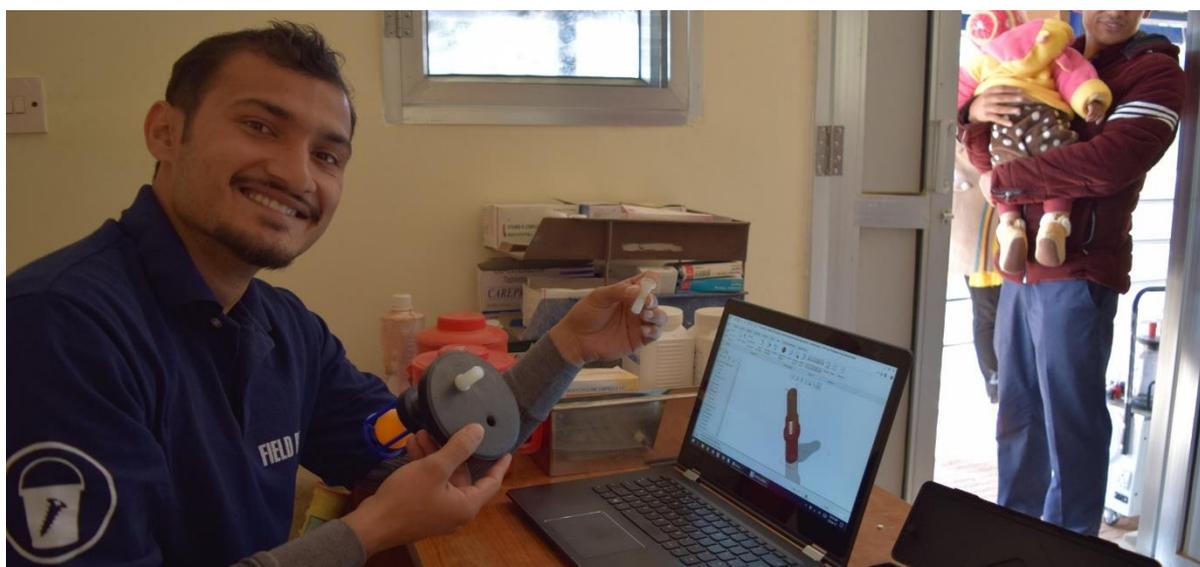
The costing shows only a small difference between the local manufacture and import of mass manufactured ones. However, it does not capture the fact that the right number of spare knobs may not have been available to be despatched straight away, and even if they were, the risk of delay (e.g., from customs) was considerably higher with that option. The situation meant that the best alternative to local manufacturing would have been either distributing stoves with a known issue meaning they could be easily damaged in transit or in use, or postponing a distribution that had been promised to the community. The existence of the local manufacturing capability meant that the issue could be resolved quickly and with a greater degree of certainty.

Vacuum pump part

Cost summary: clear cost advantage because the best alternative spare means buying more than is needed.

The costing shows a clear economic benefit to using a locally manufactured part rather than importing a replacement. The cost calculation cannot capture the fact that even if spare parts are listed on a price list from the manufacturer, it seems from the interviews we conducted that spare parts are rarely actually supplied. The explanations as to the reason for this differed – people in procurement told us distributors are unwilling to supply them, the distributor told us people rarely ask for them. Other examples from Field Ready’s work include the repair of the electrical supply to a field hospital ward, and the repair of a broken corner piece to an incubator. In both cases, the equipment was dangerous and impractical to use without it, and the cost of replacing the whole item was prohibitive.

Bringing complex equipment back into use can bring significant value, and there are potential cost savings from enabling a technician to complete a repair in a single visit, rather than needing to make one visit to assess the problem and a second visit to return with the necessary parts.



This spare part was designed and manufactured on site at the health post where it was needed.

- **Category C: Digital fabrication of mould for casting**

Improved cookstove air supply disk

Field Ready were approached by a local manufacturer of clean cookstoves to help with prototyping a new design for the air supply disk. Increasing the efficiency of the stove this would enable them to bid for Nepali government contracts, which have minimum efficiency requirements. The manufacturing method normally used for the production of their stoves is sandcasting in metal, using a wooden mould. The improved design proposed by the manufacturer was too complex to produce in wood and so he asked the Field Ready team in Nepal if they would be able to produce a mould using digital fabrication.

The resulting prototyping resulted in a mould for the disk that increased the efficiency of the stove, from 18% to 26%. This exceeded the requirement for government contracts, at 20%. In the six months since starting manufacture of the improved design, the manufacturer has sold over 2,000 of the cookstoves, generating revenue in excess of \$23,000, and with the potential to generate significant health and environmental benefits. Whilst this example does not necessarily illustrate a cost saving as such, it shows one way in which Field Ready’s work can support value creation in the local economy in Nepal.



The improved design realises health benefits whilst generating income for the local manufacturer.

Q3. How might introducing local manufacturing at the field level impact local and international merchants?

This section explores the opportunities and challenges for merchants that may arise from the local manufacture of aid supplies. In conducting this study, we discussed aid agency's stance towards sourcing more of their supplies from local markets, and whether they would consider investing in developing local manufacturing capacity to supply items needed for humanitarian relief. We also spoke to representatives from two businesses – one local, one international – that already trade with aid agencies, to see how they felt the local manufacture of aid supplies could affect them.

Demand from aid agencies for local supplies

The aid agencies we interviewed had policies in place that aimed to encourage the use local businesses in certain circumstances. The implementation of these policies are subject to review by the country level procurement team, as well as subject matter specialists, who can influence the decision whether to procure items from local or international markets.

For us, and particularly for livelihood projects, we try to purchase it within the district, at least. With health, it's different because the suppliers don't exist and with IT the procurement is all done centrally. We buy locally because we want to strengthen the local markets. Agro imports, agricultural tools, these should be available locally... If we don't buy items locally it can create conflict with the local community – 'if we have locally then why do you buy it from outside?' -Procurement manager, Agency A (INGO)

However, all of those we interviewed highlighted the lack of capacity in local markets to serve aid agencies' needs.

In terms of ease of procurement, that was being done centrally in the first three to six months of the response. When we started to work with local NGOs then procurement starts to shift locally... even then, some of those partners would come back to us and say, 'okay but this item, the volume is so great we can't find this locally, the vendors can't give us a consistent quality.' ... We'd pulled in as much as possible from the regions. It does help to re-energise the market, but it only helps if the supplies are there in the market. -Senior manager, Agency A (INGO)

Yes, global contracts can be a blocker to local supply but would the local supplier have the capacity? We would expect the suppliers in Nepal to work on a first come first served basis and there are lots of other INGOs needing the same thing – in a disaster would [the local supplier] have the staff, money, electricity, stock? -Senior manager, Agency B (INGO)

The country office staff we interviewed all gave the view that local markets were unable to supply essential items in sufficient volume. Both agencies described experiences of local suppliers being unable to meet their obligations because they had secured contracts with multiple agencies. Examples were also given of where local suppliers had been unable to provide items of a consistent quality.

We try to only purchase the low priced items but the vendors don't want that. To get the award of the contract they will put the price low and then change the price later. When they send the bill, they raise the price. -Programme manager, Agency B (INGO)

Local suppliers were seen to be subject to political pressures, giving preference to certain communities over others. This required careful oversight and scrutiny by agencies to ensure that none of their efforts are impacted in this way when engaged with local businesses and NGOs.

We put in feedback processes so that if people feel that groups are being discriminated against that we know about it. Central procurement helps in some ways – the local vendors can be politically motivated. We had to delay a goat distribution because there was someone trying to put pressure on the vendor. You can't escape it completely. -Senior manager, Agency A (INGO)

Whilst these represent challenges for aid agencies when buying locally, their interest in supporting local businesses and the perceived potential benefits mean that they also represent opportunities for local and international merchants.

Impact on local and international merchants

It is clearly possible that if the local manufacturing of aid supplies substitutes for importing items, this could mean that some local and international merchants engaged in that trade lose out. However, there are opportunities for local merchants to manufacture or sell items, and to provide services to aid agencies and other businesses. There may also be opportunities for international merchants if they are able to harness local manufacturing to reduce their own supply chain costs.

We interviewed a local merchant, a medical items importer and distributor based in Kathmandu. They had already been supportive of Field Ready's work, supporting the design and testing process. They saw a clear opportunity in Field Ready's work, in that they felt it could provide them with new items to sell.



The National Innovation Centre is one of a growing number of digital manufacturers in Nepal.

Their view was that local manufacturing of supplies could help them to fulfil small orders and to provide spare parts, though they were sceptical as to whether it would be viable as a way of meeting the volumes they would require for the orders that make up the bulk of their business. They suggested that medical students might be a market that local manufacturing could help them to reach, as students are required to buy their own equipment whilst training.

We interviewed an international merchant, the manufacturer of the cookstoves for which Field Ready manufactured replacement knobs. They told us that they already use regional distribution hubs that engage with local suppliers. For example, the rechargeable batteries in their cookstoves are a generic part and can be sourced by regional distributors rather than being shipped from their central manufacturing facilities.

This was a practice that was seen as saving both cost and time, and was seen as being one aspect of providing a good service to customers. In this sense, local manufacturing is something that could be incorporated into their existing business model.

Evidence and decision making

The aid agency and donor staff we interviewed were keen to see more evidence to help inform their engagement with local manufacturing of relief supplies. They told us that their ability to invest in local manufacturing capacity, including for testing, would depend on the availability of evidence to justify it.

We haven't got to where to put it along that line to make it work. Where would the costs build up? It's great in an emergency but how can we make it sustainable? ... The strategic prize is cost and speed and quality. If we had multiple disasters, we'd have to produce too many [of some items]. Could we locally manufacture in Nairobi or Kathmandu? Would that allow us to deploy quicker? ... Considering how supply chain needs are linked to livelihoods is then step two after the analysis of the supply chain costs. Where is it sustainable? -Senior manager, Agency B (INGO country staff)

The donor staff we interviewed also highlighted the importance of cost effectiveness in aid delivery that guided their investment in new technologies. They wanted to see detailed models that would show what items could be manufactured locally, in what volume, at what price, and they felt it was important to see those models stress tested.

We need to do some basic modelling – what products, what volume, price points? – and then stress test it. I had assumed we'd be making finished products but it's not necessarily that... We need to get a good set of numbers to show we have really understood the costs of different supply chains, that we know the potential markets. -Senior manager, major donor

Senior country office staff explained that in their experience it was important to be able to show staff examples of how the approach had been delivered in similar circumstances, so that they could begin to consider how it might be implemented in their own context. This point was reinforced when one of the field staff expressed the view that introducing new techniques part way through a response was impractical, due to the level of pressure on them to focus on delivery. One of their colleagues spoke about the importance of getting feedback from disaster affected communities to understand their perspectives on any changes to the way in which aid is delivered.

7. Conclusions

This paper has examined the work of Field Ready in Nepal to understand if, when and how manufacturing aid supplies in the field can have cost and time benefits. It has been an opportunity to analyse data and feedback, and to consider the implications for models of local manufacturing to be developed in the future.

Our investigations indicate that manufacturing supplies in this way can be a cost effective means of addressing supply chain gaps. This is especially the case where intense time pressure leads to inflated costs of items purchased through usual supply chains, or to an inability to meet a critical deadline.

There is a clear benefit to using local manufacturing where normal supply chains have been completely disrupted so that items are otherwise unavailable, or only available subject to a lengthy or indeterminate delay. Our costings show that it is possible to manufacture items for a cost that is similar to that of a mass produced item, as the lower supply chain costs offset the higher production cost.

The technology that enables the local manufacturing of aid supplies is constantly evolving. Yet even with current technologies our calculations indicate that it is possible to realise considerable cost savings.

The detailed costings indicate that the most complex item included in this study, an otoscope, represents the highest face value cost saving, with the locally manufactured item representing a seventy-five per cent cost reduction. However, this represents only one type of cost saving. The otoscope was designed to use parts all of which are available locally, meaning that the item can be maintained in the field and that the cost of maintenance is reduced.

With some basic items, the cost of a locally manufactured item appears to be higher than an imported, mass manufactured item. However, the cost advantage of imported items begins to decline once the costs of delivering to more remote locations are taken into account. It is often the case that the maintenance of equipment and infrastructure in a very remote location would require at least two visits – the first visit for an assessment and the second to return to carry out necessary maintenance or supply replacement items. With some forms of local manufacturing the machinery itself can be readily transported, meaning that some items could be manufactured in the field during an assessment, thus reducing costs further.

Producing spare parts has also proved to be an economic option for manufacturing in the field. In the example included in this study, a custom spare for a medical device, the locally manufactured item was more than ninety per cent cheaper than the spare part available from the manufacturer. This is because the part in question, a connector for a vacuum pump, was not available to buy individually. Instead, they would only sell a replacement for the entire jar of which the connector is only one component. In other cases, the only alternative is the replacement of the entire unit at a cost that is completely prohibitive.

The study briefly considered the case of a mould for an improved cookstove air supply disk which Field Ready created for a local manufacturer. This was created using digital fabrication techniques which were otherwise unavailable to them. Whilst there is no straightforward cost saving as such, it would be possible to estimate the additional economic value that the item helped to generate, which is likely to be many times the cost of manufacturing the mould.

This paper has considered the potential impact on local and international merchants if local manufacturing of aid supplies was adopted more widely. Humanitarian agencies do, in some cases, prefer to buy items locally rather than import them. This study finds, however, that the ability to source items locally is severely constrained by the limited capacity of local markets to supply them. This itself suggests that there may be opportunities for merchants who are able to more effectively meet that demand.

Whilst it is possible that some merchants would lose business, there may be other opportunities for those same merchants to adapt to incorporate local manufacturing of humanitarian supplies into their existing business model. For example, the local manufacturing of spare parts can produce cost savings for the merchant as well as the aid agencies, and some merchants already use regional distribution centres in a similar way.

It has not been possible in the course of this study to understand the full supply chain costs of the large humanitarian agencies or the Nepali government. Such an exercise could provide extremely valuable insight into when and how local manufacturing can realise radical cost savings in the delivery of aid, and the scale of the potential gains.

8. Appendix: Full Cost Calculations

Assumptions and common data

Exchange rates:

USD \$1 = NPR 103 = GBP £0.77

Design work by skilled Nepali:

USD \$24 per day

USD \$3 per hour

Wholesaler mark up on cost price: 6%

Manufacturing failure rate: 25%

Fetoscope

1. Situation

New product developed by Field Ready for trial in health posts, taken from a list of items being re-supplied to health posts by Agency A following the earthquake.

2. Data

Weight:	21	Grams per item
Manufacturing time:	128	Minutes per item

3. Field Ready Design Cost

Not calculated as this is a product intended to be made many times, so the design cost will be negligible in the medium to long term.

4. Field Ready Production Cost

Calculated production cost	2.42	USD\$ per item
Extended production cost	3.03	USD\$ per item, including allowance for failure rate

5. Cost of Best Alternative

Plastic fetoscope	2.57	Prices in USD\$ from Medical Wholesalers in
Aluminium fetoscope	3.60	Kathmandu - including transport, import duty, and local wholesaler markup

6. Conclusions

Even in Kathmandu, it is not very much more expensive to manufacture this item than to buy a new mass-produced one.

As you move further away from the capital and transport costs increase for the mass-produced item, it will certainly become cheaper to manufacture them locally.

It is certainly cost-effective to locally manufacture them when normal supply is interrupted.

Otoscope

1. Situation

New product developed by Field Ready for trial in health posts, taken from a list of items being re-supplied to health posts by Agency A following the earthquake.

2. Data

Weight:	44.4	Grams per item
Manufacturing time:	234	Minutes per item

3. Field Ready Design Cost

Not calculated as this is a product intended to be made many times, so the design cost will be negligible in the medium to long term.

4. Field Ready Production Cost

Manufacturing cost:	5.98	USD\$ - including allowance for material wastage
Components cost:	4.00	USD\$ per item
Assembly time:	0.25	Hours per item
Assembly cost:	1.50	USD\$ per item
Total production cost	11.48	USD\$ per item

5. Cost of Best Alternative

Otoscope from Pakistan	46.31	Prices in USD\$ from Medical Wholesalers in
Otoscope from Germany	154.37	Kathmandu - including transport, import duty, and local wholesaler markup

6. Conclusions

This is very significantly cheaper than the imported part. Functionality and longevity should be checked to ensure it is a fair comparison.

Medical testing and liability issues would also need to be explored to ensure all additional costs are taken into account.

In any case, it is certainly cost effective to produce this item locally if it is in a shortage situation, and it looks as though it is very competitive on a business-as-usual basis too.

Replacement Cookstove Knobs

1. Situation

Agency A ordered cookstoves from an international merchant for distribution in Nepal. The stoves took longer to arrive than planned (3.5 months) meaning that when they arrived, there was little time before the distribution dates agreed with the community.

Agency A staff states that the manufacturer would not supply replacement knobs. The manufacturer says that they would replace faulty parts free of charge, but were not informed that the knobs were faulty. In any case there may not have been sufficient replacement knobs in stock to despatch immediately.

2. Data

Number of knobs:	430	
Weight:	4.2	Grams per item
Final weight:	3	Grams per item after finishing
Weight of all knobs:	1290	Grams per item
Total weight	2000	Grams per item - including packaging + paperwork

3. Field Ready Design Cost

As this is a one-off order, design costs are included.

Design time:	2.25	Hours
Prototyping costs:	0.68	USD\$
Total design cost:	7.43	USD\$
Design cost:	0.02	USD\$ per item

4. Field Ready Production Cost

Manufacturing cost:	0.68	Per item
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5. Cost of Best Alternative

Purchase price per knob:	0.05	USD\$ - this is an estimate which it has not been possible to get the manufacturer to verify. It is thought to be a low and therefore conservative estimate in this context.
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Volume:	6.8	cm ³ per item
Total volume:	2924	cm ³
Package Dimensions	3000	cm ³
International courier	129.78	USD\$
Courier cost	0.30	USD\$ per item
Nepali import tax	101	%
Total landed cost	0.71	Per item

6. Conclusions

If the knobs had been available from the manufacturer, the cost of bringing them to Nepal on a fast courier service (~4 days) would not have been prohibitive. However, it is unlikely the knobs would have been available in such a short space of time, and it is also a more risky strategy, with the prospect of it being delayed by customs relatively high.

Speed of delivery was extremely important in this context to allow the committed distribution date to go ahead, maintaining the trust of the communities it was destined for.

If there had been more time available, it could have been arranged for a local company to import the knobs on behalf of Agency A, which would have avoided the 101% tax which applies to items imported by an INGO. Although the local company would presumably have wanted some mark-up for this service, the overall cost would likely have been lower than that of the locally manufactured knobs.

Under the circumstances local manufacture was fastest, cheapest, and best in the sense of least risky solution.

Vacuum Pump Part

1. Situation

A spare part created to fix a vacuum pump found not working in a clinic.

2. Data

Manufacturing time	34	Minutes per item
Weight:	3.74	Grams per item

3. Field Ready Design Cost

Design costs are included for this item since the design work was done for one specific job. This is a conservative costing approach since in fact this is a part commonly needed to repair this type of machine. It is therefore arguable that the design cost could reasonably be spread over many instances of printing the item and would become negligible.

Design time:	1	Hours
Number of prototypes:	1	The number of parts that were tested before an acceptable one was produced.
Cost of prototypes	0.66	USD\$
Total design cost	3.66	USD\$

4. Field Ready Production Cost

Calculated production cost:	0.53	USD\$ per item
Extended production cost:	0.66	USD\$ per item

5. Cost of Best Alternative

Cost of spare part	48.54	USD\$ - this is the cost of a replacement jar, which comes with the connector that was actually broken. The connector by itself is not available.
Cost of new vacuum pump	184.47	USD\$

6. Conclusion

There is clearly a huge benefit in using the locally made spare part, in cost terms as well as time.

Improved Cookstove Air Supply Disk

1. Situation

The air supply disk is critical to the functioning & efficiency of clean cookstoves. They are made locally using a well-established technology - sand-casting. A model is used to create the shape for the casting. In the past these models have been made of wood.

A Nepali manufacturer was producing cookstoves and selling them on the local market, but the burner efficiency rating of 18% was not high enough for them to be considered for government contracts, for which the threshold was 20%. The manufacturer had an idea for a new design of air supply disk that he thought would be more efficient, but it was too complex a shape to be made accurately from wood and he had no other way of creating a mould for the casting.

Field Ready modelled the new design using digital methods and produced a shape which was then used to create a mould allowing the new design to be cast. This has achieved an efficiency rating of 25.6%, and is now being sold to both the government and NGOs.

2. Data

Weight:	197	Grams per item
Manufacturing time:	508	Minutes per item

3. Field Ready Design Cost

As this is a one-off order, design costs are included.

Design time:	12	hours
Prototyping costs:	20.49	USD\$ - assumes the one prototype that was made before getting to a production-ready design was the same weight as the final product
Total Design Cost:	56.49	USD\$

4. Field Ready Production Cost

Production cost:	16.39	USD\$
Extended production cost:	20.49	USD\$ - This includes an allowance for material wastage. Although it is not believed there was any wastage in this case, the average is applied to all products.

5. Cost of Best Alternative

No alternative identified to be able to compare for cost.

6. Conclusions

The cost of this item cannot be compared against an alternative but rather should be looked at in the context of the value that this helped generate.