

Research Paper

Sanitation value chains in low density settings in Indonesia and Vietnam: impetus for a rethink to achieve pro-poor outcomes

Juliet Willetts, Anna Gero, Akhmad Akbar Susanto, Ryan Sanjaya, Thanh Doan Trieu, Janina Murta and Naomi Carrard

ABSTRACT

This study examined the sanitation hardware supply chain in rural, low density settings in Indonesia and Vietnam. Actual costs along the chains were investigated to understand the challenges and opportunities to support affordable sanitation in remote, rural locations. Data were collected from four remote districts in Indonesia and Vietnam through a systematic value-chain analysis comprising 378 interviews across households and supply chain actors and both quantitative and qualitative analysis. Three main findings are presented. Firstly, poor households, often located in remote areas and with lower sanitation access, often experienced higher costs to build durable latrines than households in accessible areas or district capitals. Second, locally sourced materials (sand, bricks or gravel) had a greater influence on price than externally sourced materials (cement, steel and toilet pans), even accounting for cost increases of these materials along the supply chain. Thirdly, transport and labour costs represented considerable proportions of the overall cost to build a toilet. These findings highlighted logistical and financial barriers to poor, remote households in accessing sanitation. Findings can inform strategies to improve the availability and affordability of sanitation products and services, in particular key issues that need to be addressed through government and non-government pro-poor market-based interventions.

Key words | market-based approaches, pro-poor, rural sanitation, supply chain, value chain

Juliet Willetts (corresponding author)

Anna Gero

Janina Murta

Naomi Carrard

Institute for Sustainable Futures,
University of Technology Sydney,
P.O. Box 123,
Broadway,
NSW 2007,
Australia
E-mail: juliet.willetts@uts.edu.au

Akhmad Akbar Susanto

Ryan Sanjaya

Universitas Gadjah Mada,
P2EB, Gd. Pertamina Tower Lt2, Jl Humaniora No. 1
Bulaksumur,
Yogyakarta 55281,
Indonesia

Thanh Doan Trieu

SNV Netherlands Development Organisation –
Vietnam,
3rd floor, building D, La Thanh Hotel 218 Doi Can
Street,
Hanoi,
Vietnam

INTRODUCTION

Providing access to durable latrines in remote, rural areas poses a significant challenge. A recent review of approaches aimed at improving sanitation coverage and use found that most interventions only resulted in modest increases (Garn

et al. 2016). Other evidence suggests that spontaneous movement up the ‘sanitation ladder’ following community-based approaches to change behaviour (e.g. community led total sanitation – CLTS) is limited and support for durable latrines is necessary, since ‘slippage’ back to open defecation occurs when make-shift latrines are damaged by weather and use (Tyndale-Biscoe *et al.* 2013). Crocker *et al.* (2016) found that in Ethiopia, CLTS needed supporting supply chain interventions for outcomes to be sustainable. Current approaches to improve access to durable latrines are presented in Garn

This is an Open Access article distributed under the terms of the Creative Commons Attribution Licence (CC BY-NC-SA 4.0), which permits copying, adaptation and redistribution for non-commercial purposes, provided the contribution is distributed under the same licence as the original, and the original work is properly cited (<http://creativecommons.org/licenses/by-nc-sa/4.0/>).

doi: 10.2166/washdev.2017.141

et al. (2016) and include using locally available materials and designs (Cole 2013), subsidising consumers (Perez *et al.* 2012), CLTS (Kullman *et al.* 2011) and market-based approaches to support the supply chain (Jenkins & Pedi *n.d.*; Pedi *et al.* 2011; Coombes *et al.* 2013; Nicoletti *et al.* 2016; Wei *et al.* 2016).

Many development agencies and governments specifically target remote, rural locations in their programs due to high levels of poverty and low levels of access to sanitation. While there is some evidence that market-based approaches can improve sanitation access in rural locations (e.g. Devine & Sijbesma 2011), there is a lack of understanding of if and how these approaches can work amongst poor communities in remote, difficult to access locations (Gero *et al.* 2014). Garn *et al.* (2016) highlight that access to sanitation hardware is a critical factor in latrine use, thus there is a need to inform and refine the approaches used to improve access to sanitation in remote locations where access to hardware is constrained. This research addressed the gaps in understanding the market-based approach, and poses impetus for a rethink given uncertainty in the ability of market-based approaches to equitably improve sanitation coverage in rural and remote areas (Gero *et al.* 2014).

Our research was based on value-chain analysis (VCA), which describes a sequence of related enterprises that conduct value-adding activity to a particular product, from its primary production, through its packaging and distribution, to the final sale of the product to consumers (Kaplinsky & Morris 2001). VCA helps to understand the work of the chain as a whole, the function of each link along the chain and the influence of parties outside the chain. The research mapped the value chain, and examined costs, outputs and the physical flow of commodities along the chain. Whilst VCA is an established methodology in the context of rural agriculture (Fowler 2012), it was necessary to adapt and revise the approach for this study, given the distinctive characteristics and context of the research (see Methods section).

Assessment of the sanitation value chain and its components has been undertaken in other studies (see for example Tayler *et al.* 2000; Peal *et al.* 2010; Pedi 2012) as it is well understood that different interventions to improve access to sanitation products are needed depending on the actor or place along the chain. VCA helps to understand issues of power, reasons for inclusion/exclusion from value chains, inequality and vulnerability (Bolwig *et al.* 2010) as well as desirability, feasibility and viability (Pedi 2012). By

understanding the motivations and incentives that work at each link of the chain, various solutions to sanitation challenges can be developed (Kennedy-Walker *et al.* 2014). Indeed, this was the thinking behind the UNDP-World Bank Water and Sanitation Program's Strategic Sanitation Approach in the late 1980s and remains relevant to the challenges facing those working in the sanitation sector today.

Interest in private sector roles in water and sanitation products and services is growing, both from government and non-government perspectives. The increase in programs and literature around sanitation marketing reflects this shift (Gero *et al.* 2014). However, a greater understanding of the contexts surrounding private sector viability is needed. This is especially the case in rural and remote parts of developing countries, where poverty rates are often higher than the national averages (e.g. Le & Booth 2014; Priebe 2016) (thus intervention is essential) but population density is low (thus constraining business viability).

Our study addressed the gap in understanding private sector viability in various contexts by investigating the sanitation hardware supply chain in four settings, two in eastern Indonesia and two in northern Vietnam. This paper provides an overview of the findings and their implications. For more details on the individual studies in Indonesian and Vietnam, see the author's Research Reports (Gero *et al.* 2015; Willetts *et al.* 2015).

The research aims were: (1) to map and analyse the association between latrine costs, poverty levels and toilet coverage in remote, rural areas; (2) to analyse the cost components for different latrine types across different locations and elucidate reasons for variations in costs; and (3) to analyse the viability (in terms of profits and sustainability) of the sanitation supply chain in low density, remote areas, including the impact of distance and transport cost. Our overarching aim was to contribute to improved strategies that can support availability of affordable, acceptable, durable latrines for the poor in remote, rural areas, thus promoting more equitable access to sanitation.

METHODS

Study design

A mixed methods approach was adopted to meet our research aims. The quantitative component focused on the

cost composition of latrines: materials, labour and transport. Costs and quantities of materials (e.g. cement, sand, bricks, iron, toilet pans, bamboo) at different points on the supply chain were calculated. Labour was calculated for each latrine type, based on data collected from masons in each district. Costs were based on the number of skilled masons and assistants required, the number of days and labour costs per day. Transport was calculated through a mix of sources, including costs provided from transport operators (which were comprised of a proportion of the initial outlay of the cost of the vehicle, fuel, vehicle maintenance and labour time), from householders (which comprised of fuel, number of trips required and missed labour time) and from retailer estimates.

The qualitative component examined factors understood from the literature to be influential on enterprises involved in the sanitation sector (Gero *et al.* 2014), including: access to credit, nature of personal and business relationships between actors in the chain, legal status of businesses, availability of and access to business support, nature of current consumer demand, level of entrepreneurship and risk taking. This paper reports predominantly on the quantitative component (see Gero *et al.* (2015) and Willetts *et al.* (2015) for details of the qualitative component).

Sampling

The research was undertaken in two districts in eastern Indonesia: Timor Tengah Utara (TTU) and Manggarai Timur (MT) in Nusa Tenggara Timur Province, and two districts in northern Vietnam: Muong Ang (in Dien Bien Province) and Mai Chau (in Hoa Binh Province). The specific research sites were selected on the basis of high remoteness, low sanitation coverage, low population density, low socio-economic status and field locations of the partner organisations. In Indonesia, 96 villages were selected, including three villages per subdistrict (one close to the subdistrict capital, one far from the district capital, and one mid-way). In Vietnam, 26 villages were selected in Muong Ang and Mai Chau (in a similar pattern to Indonesia, with three villages per commune, as well as five additional locations included within the research scoping phase).

Data were collected based on convenience sampling of households and masons in each selected village. The

sample of retailers, distributors/producers, and transport and credit providers was chosen using snowball sampling and tracing the supply-chain between district capitals and remote locations. A sample of local government officials and sanitation entrepreneurs (in Indonesia) was chosen based on purposive sampling to include a cross-section of relevant key informants.

Data collection

Data were collected from primary sources through semi-structured interviews, with questions based on the cost composition of latrines: materials, labour and transport. Interviews were conducted with a total of 172 households, 103 sanitation entrepreneurs or masons, 38 retailers, 18 transport providers, six banks or credit providers, 10 distributors or producers and 31 local government officials.

Data collection tools and further details regarding methodology can be found in Willetts *et al.* (2015) and Gero *et al.* (2015). The lead research organisation, Institute for Sustainable Futures (ISF), has general program approval from the University of Technology Sydney Human Research Ethics Committee for the conduct of its research. Program approval requires ISF research to be conducted in accordance with its Code of Ethical Research Conduct. Our research adhered to this Code and ethics approval was obtained prior to data collection, giving consideration to informed consent, translation, privacy (participants were de-identified) and data storage issues.

Analysis

Data analysis was undertaken using Microsoft Excel, geographic information systems (GIS, namely Google Earth and QGIS – to visualise the results) and inductive qualitative coding techniques.

In Indonesia, three models of toilet were investigated for the purposes of the analysis: Model 1 represented a lined pit and upper structure – both built with local materials; Model 2 represented a brick-lined pit, cement middle and semi-permanent upper; and Model 3 represented a septic tank with water-sealed pan and permanent structure. For Vietnam, three comparable models to Indonesia were investigated, which were government (Ministry of Health) approved

toilet types: pit latrines (also called ventilated improved pits – VIPs), double-vault latrines and septic tank latrines.

All costs were converted from local currency into USD using June 2014 currency exchange values.

Limitations

Several analytical challenges and limitations should be acknowledged. Firstly, supply chain actors were not always open to discuss their profit margins and hence at times these had to be inferred from prices at different points along the chain and transport cost data. Secondly, costs of materials collected at village level relied on recall of interviewees. Data quality varied, and data were cleaned, using proxies (e.g. costs from comparable locations) as needed. Thirdly, it was necessary to standardise the material quantities to compare costs across locations. In reality there was variation in quantities of materials used to build toilets since designs vary and many permutations are possible.

RESULTS AND DISCUSSION

Poverty, toilet coverage and toilet costs

Across both Indonesia and Vietnam, areas of high poverty were associated with areas of low toilet coverage. This was particularly evident in TTU (Indonesia) and Muong Ang (Vietnam). In TTU, toilet coverage in each subdistrict (for more durable latrines) demonstrated a strong relationship with the level of poverty of that subdistrict, with a coefficient of correlation of 0.47 (p -value = 0.02264). Further, the same areas with high poverty and low toilet coverage experienced the highest costs to build a toilet, see Table 1 for a comparison of the two Indonesian districts.

Table 1 | Comparison of poverty, toilet coverage and toilet costs in MT and TTU (Indonesia)

	MT	TTU
Poverty rate	25%	14%
Toilet coverage	5–13%	49%
Average cost to build toilet (USD)	\$792	\$459

There was also variation within the two Indonesian districts that demonstrated how the poor may be disadvantaged, and how both transport costs and high prices of locally sourced (i.e. available within the district) materials could increase the cost for the poor. In TTU, the subdistrict with the highest overall cost to build a toilet was Miomaffo Tengah, where materials cost USD\$383 (district average was USD\$356). This cost was due to high prices for sand, gravel and brick in this location. This subdistrict also had the highest proportion of poor households of all subdistricts in TTU (47% poverty). See Figure 1 for a comparison of poverty (left) and Model 3 toilet costs (right) in TTU (Indonesia).

In MT, the costs in different subdistricts varied significantly, both due to transportation costs and prices of locally sourced materials. The most expensive place to build a toilet was in Poco Ranaka Timur, where costs were 1.85 times the cost in the district capital, Borong. This subdistrict also had the second highest rate of poverty in the district (TNP2 K 2013). The higher cost in Poco Ranaka Timur was related to the high price of sand, costing USD\$23–30.50/m³ (which comprised a significant part of the overall cost) as well as high prices for gravel, rock and concrete bricks.

In Vietnam, the two districts were similarly remote, with similar average costs to build toilets. Within each district, poorer or more difficult to access communes experienced higher costs to build a toilet (see Figure 2 for Muong Ang communes). In Mai Chau, all four sampled communes had very high poverty rates (42–59%), and the highest costs were in those areas hardest to access (e.g. roads only passable by motorbike in the dry season), not necessarily corresponding to the highest levels of poverty. The section on Value chain analysis – *transport costs* further describes how cost increases are linked to remoteness and the associated costs of transport.

In remote communes in Vietnam, costs of toilets were also the highest. For pit latrines, households paid up to approximately 2.75 times the government estimates in remote locations of Mai Chau, and 1.7 times the estimate in remote locations in Muong Ang. For double vault latrines, Mai Chau's remote households paid almost 3.5 times the cost of the government's estimates.

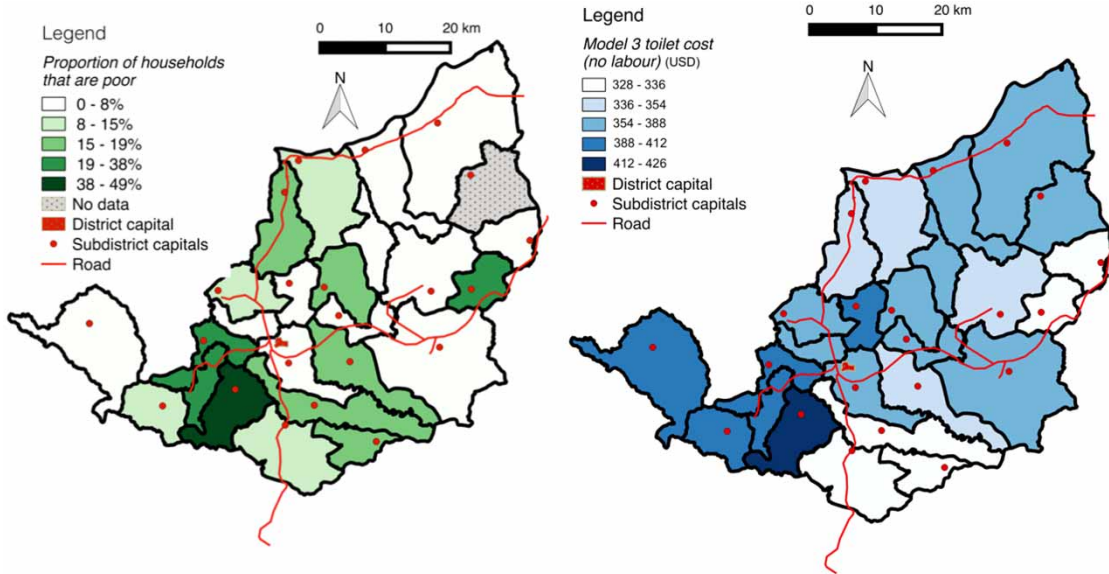


Figure 1 | Proportion of households that are poor (left) and Model 3 toilet costs (right) in TTU (Indonesia).

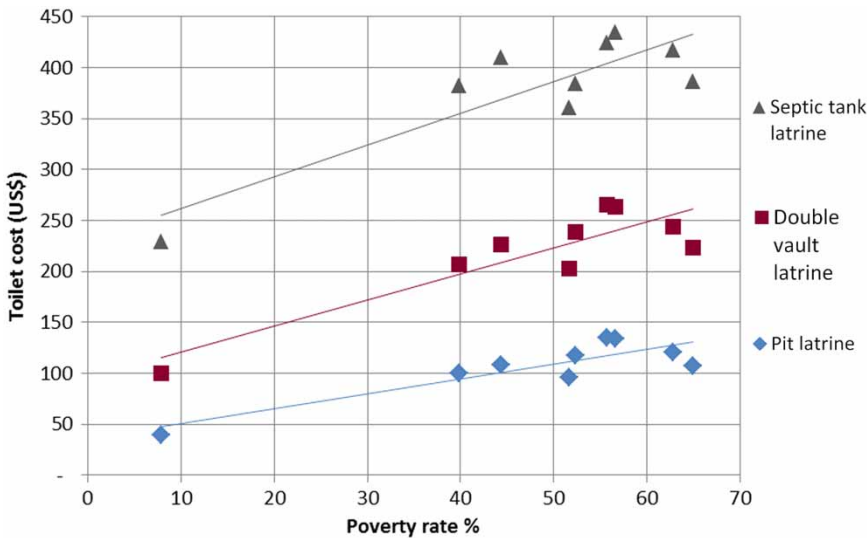


Figure 2 | Poverty rates and toilet costs for Muong Ang communes (Vietnam).

Value chain analysis

Material cost components

In Indonesia, toilets were made up of sand, wood, brick, iron, rock, bamboo, gravel, cement, pipe, zinc and toilet pans. In Vietnam, fewer materials were used: sand, cement, bricks, iron, roof tiles (for superstructure) and

toilet pans. Total costs also included transport and labour. Average, minimum and maximum costs per toilet model for the four districts included in the study are presented in Table 2.

For Vietnam, Mai Chau district costs were about 1.25 of those in Muong Ang, due to the need to purchase and transport sand (which was locally available and inexpensive in Muong Ang).

Table 2 | Average, maximum and minimum costs (in USD) to build a toilet in Indonesia (MT and TTU) and Vietnam (Muong Ang and Mai Chau)

	Indonesia costs (USD): Average (min/max)		Vietnam costs (USD): Average (min/max)	
	TTU	MT	Muong Ang	Mai Chau
Model 1	113 (79/142)	180 (118/247)	112 (89/142)	138 (96/235)
Model 2	285 (250/316)	645 (513/964)	233 (199/280)	286 (208/447)
Model 3	517 (455/575)	892 (726/1,237)	410.38 (365/509)	535 (387/812)

Note: In Indonesia, Model 1 = lined pit and upper structure (both built with local materials), Model 2 = a brick-lined pit, cement middle and semi-permanent upper, and Model 3 = a septic tank with water-sealed pan and permanent structure. In Vietnam, three comparable models were investigated: Model 1/pit latrine (also called ventilated improved pits - VIPs), Model 2/double-vault latrine, and Model 3/septic tank latrine.

In both Indonesia and Vietnam, the major cost components to build toilets were predominantly common construction materials. In Indonesia the largest cost components were cement and sand, and in Vietnam were bricks, made of clay and concrete. The cost components for a pit latrine Mai Chau communes are illustrated in Figure 3, highlighting the material (local and externally sourced), transport and labour costs. Transport costs increased with distance from the district capital, and even for the simplest of latrines comprised up to 45% of total cost for the most distant communes (see section *Transport costs* below).

Externally sourced materials

Externally sourced items (e.g. cement, steel and toilet pans) were subject to increases in costs along the supply chain;

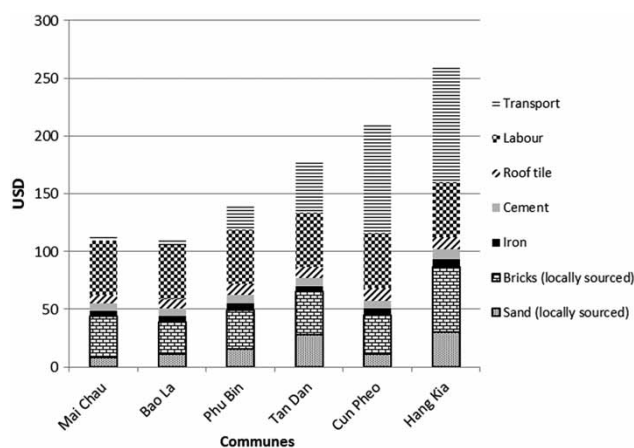


Figure 3 | Cost components to build a pit latrine in Mai Chau district, reading left to right gives district capital to most distant commune (Vietnam).

however, there was little opportunity to optimise the supply chain for these items. In Indonesia, cement comprised 21–28% of the cost of a durable toilet and offered low profit margins to actors in the supply chain. For example, in TTU, distributors reported profit margins of 5–10%, while district/sub-district retailers reported margins of 3–5% and 2–4%, respectively. Such low profit margins meant further discounts were often not possible. Furthermore, despite cost increases along the supply chain associated with transport in Indonesia, costs did not increase much for cement, even in remote locations Figure 4(c)).

Cement manufacturers were located close to both Vietnamese districts in our study. For Muong Ang district, the closest manufacturer was in the provincial capital, where cement sold for USD\$6.39/100 kg. Profit margins for cement were typically very low for retailers (between 3–7%). The more remote commune centres sold cement for higher prices to account for costs associated with transporting the material to their shop. Table 3 shows how cement increases in cost from the district capital to more remote communes. The distant communes pay 31% more than district capital (for Mai Chau) and 23% more than district capital in Muong Ang. These costs were due to retailer's transport costs (rather than reflecting higher profit margins in distant communes).

In both Indonesia and Vietnam, toilet pans had slightly higher profit margins, however they represented a very small proportion of the cost of a latrine (between 2 and 4% in Indonesia) and hence optimising this cost would minimally affect the overall cost. This illustrates the benefits of undertaking VCAs as it helps policy makers and practitioners avoid misallocation of resources (as noted by Fearné *et al.* 2012), for example, putting efforts into subsidising toilet

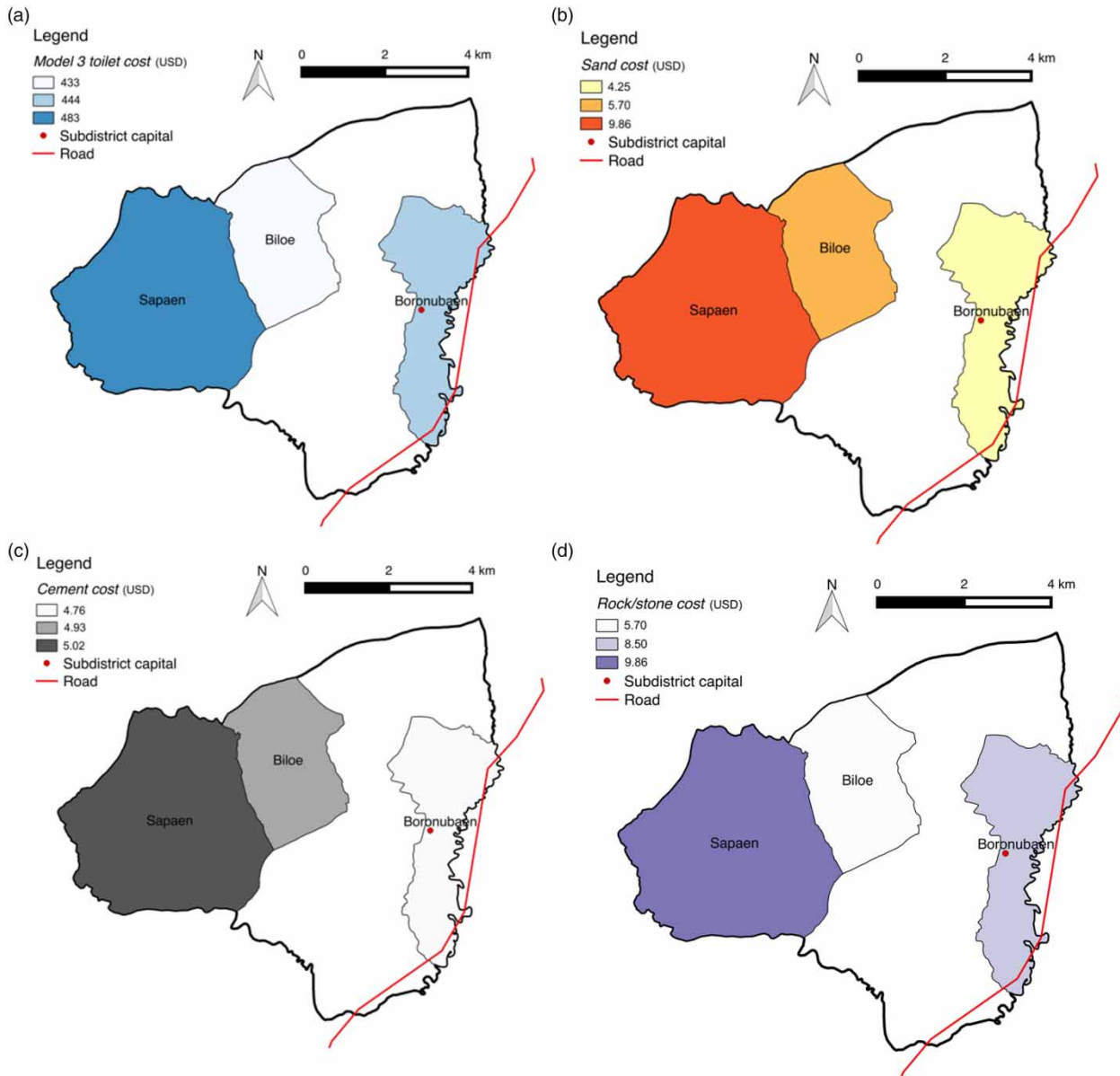


Figure 4 | Costs of (a) Model 3 toilet (per unit), (b) sand (per cubic metre), (c) cement (per sack) and (d) rock (per cubic metre) in three villages in TTU subdistrict, Biboki Utara (Indonesia).

Table 3 | Costs (USD) of cement (100 kg) from source to district capitals and communes (Vietnam)

	Muong Ang District	Mai Chau District
Source/factory cost	\$6.39	<i>unknown</i>
District capital	\$6.86	\$6.15
Closest commune	\$7.10	\$6.62
Middle-distance commune	\$8.52	\$7.10
Distant commune	\$8.99	\$7.57

panns for little gain. Toilet pans were manufactured in Java Island and transported and distributed through Surabaya. Local production of toilet pans in TTU had been initiated through support from Plan Indonesia (sold for USD\$3.60 per unit). Cheaper brands sold by manufacturers near Surabaya cost USD\$5.80 per unit.

In Vietnam, toilet pans were manufactured in provinces near to Hanoi, e.g. Thai Binh province. In Muong Ang, one of the most significant costs involved in toilet pan purchase

for locations outside the district centre was transport, for example, in Ang To commune, squat pans were sold at five times the price (USD\$5.68 per unit) as in Muong Ang town (USD\$28.39 per unit). In Mai Chau, one commune shop owner noted the profit margin on squat pans sold was 5–7%.

Locally sourced materials

Our VCA also analysed locally sourced materials (sand, gravel, wood, rock, bricks and bamboo). Price variations for these items in both countries were significant, often outweighing the variations in cost of externally sourced items. Given that these are major cost components when building a toilet (e.g. Figure 3), the overall cost of a toilet was significantly influenced by variations in such prices.

In Indonesia, in some locations sand and gravel were five times the price as in others, while bricks were double the price as in others. Bamboo varied 25-fold and wood five-fold in TTU, while in MT bamboo varied seven-fold and wood three-fold. In MT the government introduced a fee for removal of sand, gravel and rock which further affected prices. Figure 4 highlights the large variation in price of sand and rock (Figure 4(b) and 4(d), respectively) compared to little variation in cement price (Figure 4(c)) and overall price for Model 3 toilet (Figure 4(a)) for a subdistrict in TTU.

In Vietnam, sand was readily available in Muong Ang and cost was minimal, while in Mai Chau, sand comprised over 30% of material costs in some communes. Bricks (clay and cement) were also produced locally in both districts. The cost of cement bricks differed considerably between the two districts: in Muong Ang they cost approximately USD\$0.06 per brick, while in Mai Chau they cost approximately USD\$0.11 per brick. Bricks comprised the largest proportion of material costs for both districts – on average, 50% of the cost in Mai Chau and 46% in Muong Ang for pit latrines.

Additional data, including material costs for each toilet type in Vietnam communes and Indonesian subdistricts, can be found online in the Supplementary material.

Transport costs

The VCA incorporated analysis of transport costs. In Indonesia, the condition of the roads of approximately half of

the surveyed villages in TTU was reported to be poor or very poor. This posed a barrier to households, as logistically it was difficult for materials to be delivered to their homes, particularly given most households (89%) arranged transportation of materials to their villages themselves. Surveyed villages were between 13–56 km from their subdistrict capital. In the latter case, transportation costs comprised 9% of the total cost of materials in that location. In MT the cheapest transport of latrine materials from a materials shop to surveyed subdistrict was USD\$12.60 (Poco Ranaka) and highest was USD\$54.80 (Elar Selatan), with latter costs due to geographical challenges.

In Vietnam, households in remote villages also faced barriers in transporting materials to their homes due to poor quality roads that were often inaccessible by truck. Motorbike transport and access on foot using local labourers were common transportation modes to locations. Such transport was either self-arranged or arranged through truck transporters, who acted as a middleman in purchasing then transporting materials to as close as possible to the household.

Since transportation by motorbike is common in Vietnam, we calculated the number of trips required to transport the weight of materials used to build each toilet type, using the local capacity of a motorbike. Results showed that to transport the materials for a pit latrine, 42 trips by motorbike were required. Even for households living close to the village centre (or from the materials pick-up point), considerable time was needed to dedicate to this task, as well as fuel costs and potential missed labour time. This was a significant barrier to households accessing even the simplest of hygienic latrine options. For transportation of septic tank latrine materials, 229 trips were required which was unrealistic to think a householder would dedicate time towards.

Labour costs

Labour comprised a significant cost as a component in building a latrine. It took over 8 labour days (consisting of a skilled mason and an assistant) to construct a Model 3 latrine in Indonesia, while in Vietnam estimates were for 11 days for a septic tank latrine. In Indonesia's TTU district, the labour cost was 28–39% of the total cost of the latrine,

and in MT it was 24–29%. In Vietnam, for pit and double vault latrines in both districts, the proportion of labour varied to similar degrees, being between 25 and 50% of total cost. The proportional cost of labour for septic tank latrines was less, around 30% of total cost in both districts.

CONCLUSION

This research provided insights into the realities associated with sanitation value chains in rural, low density settings in Indonesia and Vietnam. Three major findings were reported.

Firstly, across both Indonesia and Vietnam, areas of high poverty (which were also usually the more remote locations) often experienced high costs to build a toilet. High costs were associated with high transport costs, and this was particularly the case for Vietnam. In the context of the Sustainable Development Goals and the principle to achieve universal access, there is a case to explicitly target locations with high poverty rates and high costs of toilet provisions and develop differentiated approaches that address this situation.

Secondly, toilet costs were made up of costs of externally sourced items, subject to increases in costs along the supply chain and transport costs, and locally sourced items which were subject to local variations in availability and price. In the case of externally sourced items such as cement and toilet pans, there was little opportunity to optimise the supply chain. For locally sourced items (sand, gravel, rock, bricks, etc.), price variations were significant and could outweigh the variations in cost of externally sourced items. When developing interventions to enable poor households have greater access to hygienic sanitation, it is therefore important to gain an understanding of context-specific costs of materials. This contextual understanding should inform which toilet designs (based on their component materials) are promoted, with a view to minimise cost.

Thirdly, transport and labour represent considerable proportions of the overall cost to households for building a latrine. Transport costs were highly variable depending on the location. In Vietnam, transport costs and logistical arrangements in obtaining sanitation products in remote villages were a prohibitive cost for many households, presenting a barrier to poor, remote households in accessing

sanitation. There may be room to reduce transport costs through development of business models that include transport. In both Indonesia and Vietnam, labour was a significant cost component, which presents an opportunity to consider how such costs might be subsidised or reduced.

The findings presented in this paper are important for considering approaches to address access to sanitation in remote rural areas. To fulfil the objective of improving the availability and affordability of products and services to build toilets, particularly in areas of higher poverty, there are a range of actions which can be considered when designing interventions. These include: seeking opportunities to reduce costs of locally sourced materials or choosing designs that use lowest priced materials in a given location; improving access to finance for customers; organising communities for collective purchasing; and/or smart targeted subsidies which could be for transport, applied in certain geographical areas, or used to incentivise local suppliers and entrepreneurs to serve certain groups. Such strategies have implications for both CSOs, private sector and government, who all have roles to play in enacting such approaches, and whilst they may introduce complexity to manage, are indeed needed if those in the ‘last mile’ are to be reached.

ACKNOWLEDGEMENTS

The research has been funded by AusAID through the AusAID Development Research Awards Scheme under an award titled Civil society support for water and sanitation services for the poor. The views expressed in the publication are those of the author(s) and not necessarily those of the Commonwealth of Australia. The Commonwealth of Australia accepts no responsibility for any loss, damage or injury resulting from reliance on any of the information or views contained in this publication. The authors wish to thank research participants in Indonesia and Vietnam for their valuable contributions to the research.

REFERENCES

- Bolwig, S., Ponte, S., du Toit, A., Riisgaard, L. & Halberg, N. 2010 [Integrating poverty and environmental concerns into](#)

- value-chain analysis: a conceptual framework. *Development Policy Review* **28**, 173–194.
- Cole, B. 2013 *Participatory Design Development for Sanitation*. Frontiers of CLTS: Innovations and Insights, Issue 01, November 2013, report produced for UNICEF Malawi.
- Coombes, Y., Davies, W. & Pedi, D. 2013 *Kenya Onsite Sanitation: Market Intelligence*. Water and Sanitation Program (WSP), Washington, DC, USA.
- Crocker, J., Geremew, A., Atalie, F., Yetie, M. & Bartram, J. 2016 *Teachers and sanitation promotion: an assessment of community-led total sanitation in Ethiopia*. *Environmental Science and Technology* **50**, 6517–6525.
- Devine, J. & Sijbesma, C. 2011 *Sustainability of sanitation marketing in Vietnam: findings from a new case study*. *Waterlines* **30**, 52–60.
- Fearne, A., Martinez, M. G. & Dent, B. 2012 *Dimensions of sustainable value chains: implications for value chain analysis*. *Supply Chain Management: An International Journal* **17**, 575–581.
- Fowler, B. 2012 *Pathways out of Poverty: Tools for Value Chain Development Practitioners*. USAID Microreport #180. US Agency for International Development, Washington, DC.
- Garn, J. V., Sclar, G. D., Freeman, M. C., Penakalapati, G., Alexander, K. T., Brooks, P., Rehfuess, E. A., Boisson, S., Medlicott, K. O. & Clasen, T. F. 2016 *The impact of sanitation interventions on latrine coverage and latrine use: a systematic review and meta-analysis*. *International Journal of Hygiene and Environmental Health* **220**, 329–340.
- Gero, A., Carrard, N., Murta, J. & Willetts, J. 2014 *Private and social enterprise roles in water, sanitation and hygiene for the poor: a systematic review*. *Journal of Water, Sanitation and Hygiene for Development* **4**, 331–345. DOI: 10.2166/washdev.2014.003.
- Gero, A., Willetts, J., Murta, J., Doan Trieu, T. & Mohr, S. 2015 *Sanitation Value Chains in Low Density Settings in Vietnam*. Enterprise in WASH – Research Report 2, Institute for Sustainable Futures, University of Technology, Sydney.
- Jenkins, M. & Pedi, D. n.d. *Equity in Sanitation Marketing: How can we Support the Market to Reach the Poorest?* (No. 8). UNICEF, New York.
- Kaplinsky, R. & Morris, M. 2001 *A Handbook for Value Chain Research*. Report prepared for IDRC.
- Kennedy-Walker, R., Evans, B., Amezaga, J. & Paterson, C. 2014 *Challenges for the future of urban sanitation planning: critical analysis of John Kalbermatten's influence*. *Journal of Water, Sanitation and Hygiene for Development* **4**, 1–14.
- Kullman, C., Ahmed, R., Hanchett, S., Khan, M. H., Perez, E., Devine, J., So, J. & Costain, C. J. 2011 Long term sustainability of improved sanitation in rural Bangladesh. In: *Water and Sanitation Program* (A. Grossman, ed.).
- Le, H. T. & Booth, A. L. 2014 Inequality in Vietnamese urban–rural living standards, 1993–2006. *The Review of Income and Wealth* **60**, 862–886.
- Nicoletti, C., Wei, Y., Taylor, S. & Lestikow, G. 2016 An approach to measurement of the sustainability of sanitation of WASH programs. In: Briefing Paper 2443, *39th WEDC International Conference*, Kumasi, Ghana, 2016.
- Peal, A., Evans, B. & Voorden, C. v. d. 2010 *Hygiene and Sanitation Software: An Overview of Approaches*. Water Supply & Sanitation Collaborative Council, Geneva, Switzerland.
- Pedi, D. 2012 *Sanitation Supply Chain Analysis Pemagetshel Dzongkhag: PHED-SNV Rural Sanitation and Hygiene Programme*. SNV, Thimphu, Bhutan.
- Pedi, D., Jenkins, M., Aun, H., McLennan, L. & Revell, G. 2011 The ‘hands-off’ sanitation marketing model: emerging lessons from rural Cambodia. In: *The Future of Water, Sanitation and Hygiene: Innovation, Adaptation and Engagement in A Changing World*, pp. 1–4. 35th WEDC International Conference, Water, Engineering and Development Centre (WEDC), Loughborough, UK.
- Perez, E., Cardosi, J., Coombes, Y., Devine, J., Grossman, A., Kullmann, C., Kumar, C. A., Mukherjee, N., Prakash, M., Robiarto, A., Setiawan, D., Singh, U. & Wartono, D. 2012 *What Does It Take to Scale Up Rural Sanitation?* Water and Sanitation Program (WSP).
- Priebe, J. 2016 *How robust is Indonesia's poverty profile? Adjusting for differences in needs*. *Bulletin of Indonesian Economic Studies* **52**, 229–248.
- Taylor, K., Colin, J. & Parkinson, J. 2000 *Strategic Planning for Municipal Sanitation: A Guide*. GHK Research and Training, London.
- TNP2 K 2013 *Integrated Database for Social Protection Program, Indonesia*. <http://bdt.tnp2k.go.id/index.php/data/sebaran-kab-kota> (accessed 21 October 2014).
- Tyndale-Biscoe, P., Bond, M. & Kidd, R. 2013 *ODF Sustainability Study*. Plan International.
- Wei, Y., May, A. & Chowdhury, R. 2016 Instituting equity and inclusion in market-based approaches: reaching the poor and disabled in sanitation. In: Briefing Paper 2522, *39th WEDC International Conference*, Kumasi, Ghana, 2016.
- Willetts, J., Susanto, A. A., Sanjaya, M. R., Murta, J. & Carrard, N. 2015 *Sanitation Value-Chain in Nusa Tenggara Timur Indonesia*. Enterprise in WASH – Research Report 1, Institute for Sustainable Futures, University of Technology, Sydney.

First received 14 October 2016; accepted in revised form 30 March 2017. Available online 26 July 2017