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LifePump Usage Data for Developing Handpump Predictive Maintenance Analytics

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Abstract

In rural areas where handpumps are commonly used to access clean water, it is critical that the handpumps remain operational for year-round safe water access. This access is sometimes limited by the difficulties in extracting water from ultra-deep boreholes, fluctuating water tables due to seasonal changes and climate change, and the prevalence of broken or unreliable handpumps [1-4]. Demand for resilient ultra-deep handpump technology is growing, and the need for newer appropriate technologies which ensure handpump uptime is just as important, particularly as global WASH initiatives aim to guarantee access to safe water for all by 2030.

Design Outreach has designed a hand pump, the LifePump, that can reach up to 150 meters deep, and has a targeted operational hardware lifespan of 30-yrs, with 5-yr maintenance intervals under typical usage. Typical usage was defined as approximately 5 hours/day during the LifePump development phase by collecting requirements and information on hand pump usage from WASH implementers. The progressive cavity design of the LifePump prevents sudden catastrophic failures, but rather lends itself to gradual wear under increased loads and over time in use. Through data collected from the LifePumpLink, a remote monitoring data system, which collects and transmits data obtained through a sensor attached to the LifePump, it is now possible to directly measure daily pump usage. Initial results show that average usage can widely vary from community to community, ranging from as little as 1 hour/day average usage, to as many as 14 hours/day on average, with peaks of 21 hours.

While the first LifePump has been running without interruption in the community of Zolomondo, Malawi since 2013 [5], it was 2018 when Design Outreach began collecting usage data from what is now over 50 LifePumps with LifePumpLinks installed. Additionally, in 2019, the LifePump received national policy acceptance in Malawi and Zambia. The data in the current study represents a subset of pumps installed in Malawi, Zambia, Zimbabwe, Haiti, Central African Republic, Kenya, and most recently, Guatemala, and is representative of over 492,000,000 drive rod rotations.

So far, the data is revealing that the subset of pumps (n=54) are used on average 4.9 hours/day, confirming the original LifePump definition of typical daily usage. However, the data widely varies and is positively skewed (standard deviation = 3.1 hr; min = 0.4 hr; max = 14.1 hr; skewness = 1.2 hr) (Figure 1). The average pump depth is 58.0 meters (standard deviation = 22.7 m; min = 18 m; max = 150 m). The long-term reliability of the LifePump is a function of actual pump usage and depth, which determines loading, and therefore knowing both metrics is critical to predicting future pump performance (Figure 2). We endeavour to build a predictive maintenance analytics module which would allow government water ministries, non-governmental organizations (NGOs), and private sector partners to better account for the wide variation in pump usage and to anticipate and proactively plan preventative maintenance checkpoints.

Through our custom user interface and dashboard, we present the data in a meaningful format, translating operational data into real-time actionable indicators, alerts, and recommendations (Figures 3,4). Design Outreach is positioned to provide the premiere solution for not only near 100% uptime, but also resource management, both for staff deployment to communities with pumps, and for community funding for pump maintenance.

Figure 1. Histogram, Average Daily Time in Use

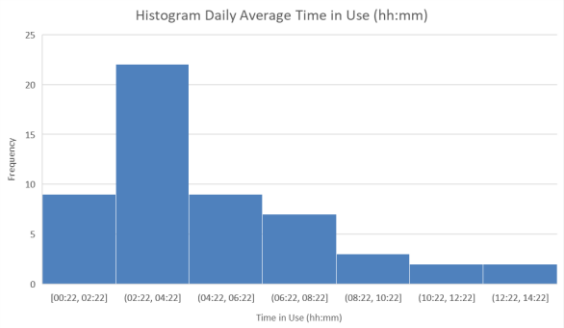


Figure 2. Pump Depth vs Avg. Daily Rotations

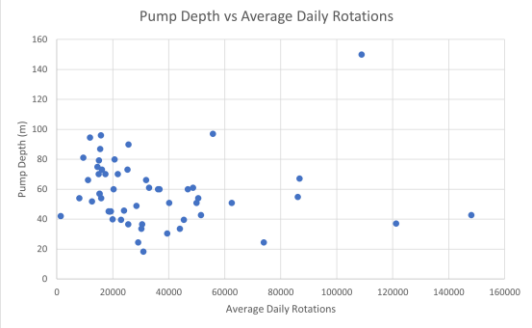


Figure 3. LifePump Dashboard, example #1

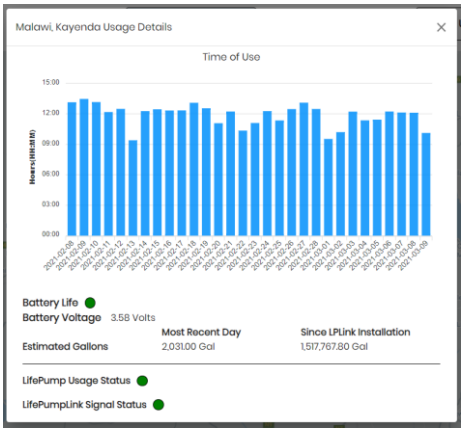
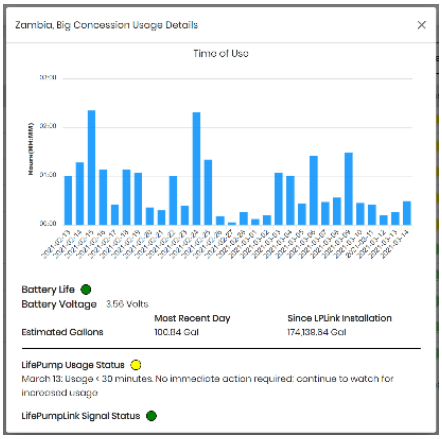


Figure 4. LifePump Dashboard, example #2



References

1 Chilton, J. (2014), RWSN Webinar Series, UPGro, NERC.
2 The World Bank (1984), The World Bank, Washington DC, USA.
3 Cornet, L. (2012), Cranfield University, MSc Thesis.
4 RWSN (2009), RWSN, St Gallen, Switzerland.
5 Bixler, G.D., et al. (2016), 7th RWSN Forum, Cote d'Ivoire.

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