Abstract for Complex R.O.M.E. 2026

Title

Agent-based modelling of Harappan Artefacts - Exploratory study into the past scenarios and present material

Abstract

Harappan seals were a hallmark of Mohenjo-daro, one of the earliest cities in the world. These small stone objects were engraved with images and could be used to make impressions in clay, providing a means of preserving and exchanging information. They exemplify the material, iconographic, and intellectual breadth in the Harappan world and provide the largest source of imagery in its archaeological corpus. Despite their importance, their use is poorly understood. Much current scholarship on Harappan seals and sealings theorises that the primary use of seals was analogous to the use of similar objects in neighbouring Mesopotamia: creating impressions of engravings for possible use in economic or administrative activities. However, factors such as meagre quantities of sealings and seal impressions on artefacts, their small proportion compared to seals, the minimal wear and tear of the seals themselves,, and the exclusion of copper and bas-relief tablets from this narrative reveal the need for fresh inquiries. This project approaches their use using Agent-Based Modelling (ABM) (Wilensky, 1999-2023) to analyse the deposition pattern of seals and impressions recovered in excavations at Mohenjo-daro. ABM is a computational technique that can be used to simulate the quantities of seals and their impressions under different conditions. ABM allows us to probe and explore this narrative through data simulation, and thus build possible alternate interpretations of this key artefact in some of the world's first cities.

The material and typo-technological studies performed on these artefacts, collectively called as ‘Marked Harappan Artefacts’ - MHA (Gokhale 2024) have identified iconographic patterns (Rissman 1989, Franke 1991), size groupings (CISI 1987, Konakusava 2018), individual carving styles and techniques (Green 2015, Jamison 2017), material variation (Law 2005), and temporal evolution to some extent (Kenoyer 2006, Konakusava 2014). Besides these, a vast scholarship deals with the signs present on these artefacts, their possible linguistic nature, associated languages, and the significance of these possibly ‘textual’ materials in contemporary culture (Possehl 1996). However, though the scholars opine about their possible use in economy (Rao 2018), trade (Vidale 2007), or local administration (Frenez 2005), we have yet to fully understand their usage mechanism, production-use-reuse-discard strategies, and ‘value’ - notional or intangible - in the contemporary society. Ethnographic and historical studies have examined how human tendencies can lead to specific artefactual outcomes. In the context of material-reuse, there are interesting observations from Medieval India (Sohoni and Gokhale 2021) that may have relevance to the Harappan case. Our project experiments with a material-centric view to carry out a reappraisal of the mentioned Harappan artefacts using ABM.

This project demonstrates an in-depth initial enquiry using the ABM technique on the artefacts from the DK-G(S) mound of Mohenjo-daro (Gokhale and Ameri 2026). Based on the existing quantities of artefacts recovered from this mound, we incorporate different hypothetical parameters such as life span of artefacts, tentative quantity of impressions produced by each seal, average span of a household etc. Based on these, we simulate different scenarios and observe the hypothetical quantities of preserved (?) artefacts through those. The preliminary observations from this experiment suggest that if all seals were being used to create multiple sealings, then the quantity of recovered sealings should have been larger than what presently exists. ABM affords an opportunity to conceptualize the multiverse of the past and to investigate the possibly multi-faceted role of these artefacts in the 4500 year old urban society. It is crucial to note that the models do not represent the past but our ideas of the past based on parameters that we ourselves have set.

Finally, at a more abstract level, beyond the discussions of Harappan or Mesopotamian civilisations, seals, sealings, and tablets, archaeological data is often a distorted and shrunken version of the past material. As noted by Peregrine (2018), the parent population is unknown in almost all the cases. Thus, we remain oblivious to whether the artefactual evidence that we collect is representative of the actual material evidence had the entire site been excavated and had all artefacts been collected. While it is not the goal of such modeling to achieve ‘verisimilitude’, creating ‘thesis-driven’ ABMs based on valid primary and secondary sources "should help us say something new" about the past (Gavin 2014, 42).

Thus, though this project proposes to implement ABM for Harappan artefacts, the broader interest is to ideate and simulate innumerable events, scenarios, agencies, and intentions from the past which lead to the present day archaeological evidence available to us. Moving forward, it proposes to identify and incorporate factors which impact the survival of the artefacts in the archaeological past, post-depositional phase, and the excavation phase.

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