Archaic Technology, Social Relations and Innovations in Brick Kilns

Research Study as part of the Project:

Empowering CSOs for Decent Work
and Green Bricks in India's Brick Kilns

J. John

Centre for Education and Communication
New Delhi

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"...Caste System is not merely division of labour. It is also a division of labourers. Civilized society undoubtedly needs division of labour. But in no civilized society is division of labour accompanied by this unnatural division of labourers into water-tight compartments. Caste System is not merely a division of labourers which is quite different from division of labour—it is an heirarchy in which the divisions of labourers are graded one above the other. ..What efficiency can there be in a system under which neither men's hearts nor their minds are in their work? As an economic organization, Caste is therefore a harmful institution, inasmuch as it involves the subordination of man's natural powers and inclinations to the exigencies of social rules."

Dr. B.R.Ambedkar, Annihilation of Caste pp. 46-47

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Acknowledgments

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J. John
New Delhi
23 December 2017

Foreword

There is no doubt that brick-making has been one of the centuries-old practices in India with the history of making bricks can be traced back to the Indus Valley Civilisation. While there is no clarity on the technology used then, the most commonly used technology in current-day India is the *fixed chimney bull trench kiln* (FCBTK) technology and, to some extent, the *clamp* technology. History suggests that clamp technology existed in India before the advent of the British, whereas FCBTK is believed to have been introduced by W. Bull, a British engineer in 1876. Surprisingly, there have been very little innovations since then.

India is also known to be the second-largest producer of clay-fired bricks in the world, accounting for more than 10 per cent of global production through its 150,000 to 200,000 brick kilns. The brick industry is a major source of livelihood for people in Assam, Bihar, Haryana, Punjab, Uttar Pradesh (UP) and West Bengal, accounting for the employment of an estimated 15–20 million workers.

However, strangely, the industry is still characterised as one of the most traditional and informal sectors, with limited technological innovations, low mechanisation rate and the practice of gendered feudal labour relations. The persistence of caste-based division of work, the system of recruitment based on payment of advance, the calculation of wages based on piece-rate, the non-recognition of women as workers and the employment of child labour, still dominate the industry; further perpetuating the existing social relations and accentuating the vulnerability of workers to exploitation. To top this, the industry is considered to be one of the major contributors to air pollution, coupled with fact that it is a major violator of labour laws.

Whereas field insights suggest that one of the primary factors behind the unwillingness of brick manufacturers to invest in modern technologies is the uncertainty of government regulations and directives regarding the closure of kilns due to various environmental concerns, there is a severe dearth of a systematic investigation into the situation and factors that contribute to the traditional and informal nature of the industry.

In this backdrop, Centre for Education and Communication (CEC) decided to explore the situation systematically, to understand why innovations in brick kilns are rare and how this is linked to industrial relations that are not different from caste-based social relations. In doing so, CEC rests itself on the hypothesises that the brick-kiln manufacturers' capacities to innovate depend on a) facilitating a labour market, based on information flow, and b) an industrial relations, based on observation of labour standards and recognition of skills rather than casteism, regimentation, bondage, contractors, and gendered feudal labour relations.

The study, conducted as part of CEC's ongoing EU-funded project titled 'Empowering CSOs for Decent Work and Green Bricks in India's Brick Kilns', has analysed the process of innovations in the history of brick-making in India and has thrown light on the factors contributing to the sluggish rate of innovations and mechanisation in the brick-kiln sector vis-a-vis the factors that have led to entrepreneurial and technological innovations in other related sector/s.

As a first step to inform relevant stakeholders about the situation, CEC shared the findings of the study in a formal gathering in Delhi and gathered recommendations. These have been incorporated in this volume. We are sure this report, in the current form, will be of tremendous value to inform stakeholders about the factors contributing to the persistence of the traditional and the informal nature of the industry; and how lack of innovations is linked to industrial relations (which are not different from caste-based social relations) in the brick kilns of India. CEC expects that the findings of the report will be instrumental in generating discussions on alternatives, to ensure innovations in India's brick-kiln sector, which will mutually benefit both the workers and the owners of the brick kilns.

The study was conducted by Mr. J. John, with support from Pritom Saikia, then Senior MIS Officer of CEC. My sincere thanks to the researchers for all their efforts to bring out such a valuable document.

Arati Pandya
Executive Director
Centre for Education and Communication

5th March 2018

Preface

India is the second largest producer of clay-based bricks in the world, the first being China, where manufacturing is increasingly dominated by modern technologies with lower emissions than those encountered in India, like Hoffman kiln or tunnel kiln. There are no official figures, from the NSSO or the Annual Survey of Industries, on the exact number of kilns producing bricks in India. Based on figures provided by the All India Brick Manufacturers Association, it has been estimated that about 74.64 per cent of the 247.87 billion bricks produced in the country are made with fixed chimney bull's trench kiln (FCBTK), an exclusive technology pervasive in India and other South Asian countries including Pakistan, Bangladesh, Nepal and Afghanistan. Another 20.17 per cent are manufactured in clamp kilns, a method universally followed all over the world and now discarded. There are two major implications. One, guzzlers of coal, both the technologies are thermally inefficient and a huge source of particulate matter emissions (PM10 & PM2.5) and one of the largest industrial emitters of greenhouse pollutants, CO2 and black carbon. Workers are exposed to the high concentrations of particulate emissions, to the tropical sun, and to the extreme heat of the kilns. Two, besides being ecologically disastrous, technically inefficient, and the cause of occupational hazards, India's (and other South Asian countries') brick kilns are also scenes of the worst forms of employment practices, being more or less havens of slave labour. Kilns are seasonal and workers are mostly migrant families from within or outside the state. Most of the workers, especially those who prepare clay and mould bricks, are bonded labourers as they are forced to work 12 to 18 hours daily so as to repay the advances taken from contractors before they set off to work from their villages, most often unsuccessfully in a single season. Couched in the language of 'skill-based labour', brick kilns practise caste-based hierarchical division of labour; preparation of clay and moulding are invariably carried out by Dalits and Adivasis, and the firemen are mostly from upper castes. A historicity is attributed to this division of labour and is not interchangeable in practice, also for reasons of restrictions in inter-dining and co-habitation.

It is the latter phenomenon that is the subject matter of this paper. Are the defining characteristics of India's (and South Asia's) brick kilns – namely, caste-based hierarchical division of labour and bonded labour – in any way linked to the technology of production of bricks put into practice here? A related question is about what has prevented innovations in India's brick kilns; whether caste-based recruitment is a factor preventing adoption of other technologies in India which are being universally adopted in the production of bricks. This problematic area has never been subjected to scrutiny in India's context, probably because of the presumption that aspects like caste-based occupations and bonded labour are natural ingredients to the Indian brick-kiln industry, which is usually described as 'artisanal', 'informal', 'traditional', 'unorganised', etc. A corollary to this position is a presumption that *'the situation has been like this for decades, if not centuries,'* as a BBC reporter (Humphrey Hawksley) described the situation of brick-kiln workers in Hyderabad in 2014. Secondly, it may be because of an ideologically coloured argument that technological changes cannot bring about changes in social relations. This paper interrogates a potential relationship between lack of innovations in India's brick-kiln production and the existence of caste-based division of labour, in two stages.

In the first stage, the paper empirically examines a proposition that caste configuration in the kilns changes when the technology adopted by the brick kilns changes. Case studies of clamp kilns, fixed (and moving) chimney bull's trench kilns, down-draught kilns and tunnel kilns show that as the technology of brick production picks up, the rigidity in caste-based deployment of labour eases. Higher the technology, higher the possibility of Dalits and Adivasis getting into occupations not meant for them in the low-technology kilns. Nevertheless, the findings come with a rider. Regimented caste division does not exist in clamp kilns owned and managed by Kumhars, the traditional brickmakers of India; rather, it started with the bull's trench kiln, indicating that it was an innovation and marked a break from the traditional methods of brickmaking in the country. On the other side, caste-based occupational rigidity need not necessarily disappear as technology improves.

This took us to the second stage of the interrogation where

we asked questions like when and why was the technology of bull's trench kiln introduced, what purpose did it serve, who the innovators were, and how did regimented caste-based division of labour become the hallmark of the bull's trench kiln. All these aspects are examined in five sections. Section one deals with the persistent inconsistencies in the information on brick kilns, which incidentally arises out of the confusions in defining the status of brick kilns. Though governmental and academic documents correlate the increase or decrease in the number of brick production to the growth or deceleration of the construction industry, there are grave inconsistencies in the information on brick kilns. The current study indicates that these inconsistencies are because of the general characterisation of brick kilns as an artisanal industry and, hence, though National Industrial Classification (NCO 2008) Codes classify brick kilns under 'manufacture of intermediate and final products from mined or quarried non-metallic minerals, such as sand, gravel, stone or clay', the Annual Survey of Industries (ASI) and other statistical sources do not capture these establishments. Consequently, first, from an administrative perspective, brick kilns are allowed to operate in a grey area with respect to legal compliances though the brick kilns are subjected to various laws and administrative regulations by various departments; second, there is gross underestimations of the number of brick kilns operating in India; third, brick kilns contribute to atmospheric, soil and water pollution; and fourth, brick kilns act as havens of 'bonded labour' and 'slave labour' in India.

Section two discusses the theories on innovation and how these can be relevant and be applied to innovations in brick kilns. The section discusses the meaning and relevance of 'innovation' as predominantly understood, linking it to a firm, markets and consumers; the importance of 'application' of innovation; how innovations contribute to economic and social change; differential implications that product and process innovations will have on employment; unintended consequences of innovation, etc. The section examines how a historical understanding of Schumpeterian notion of innovation can locate an 'innovator' in a country or its agenda; and how scientific inventions and technology can be used for domination and colonialism. This shift from an enterprise-centric approach to the political and policy space, the section argues, is relevant in the study of the relationship between caste and technology in the brick kilns. It further derives its analytical perspective from Daniel R. Headrick, who offers an authentic historical exposition on the relationship between technological innovation and imperialism.

Section three explores the modes of making and using bricks in ancient and medieval India and the attendant social relations based on reinterpretations of available literature and deciphering architectural styles of those periods. Architecture is approached here not just as a cultural reflection, but also as a reflection of power relations within society and nations. The ubiquitous presence of high-quality bricks – sunburned and fired – in the ancient Indian civilisations of Harappa and Mohenjo-daro and the disappearance of brick culture during the Vedic period are discussed. No evidence has been given by archaeologists to indicate slave labour in the production of bricks during the period. Since the imperial Mauryas, burnt brick and stone have been continuously in use as building materials in the alluvial plains of India. Towards eastern India, Buddhist temple complexes were built in Bengal and Bangladesh. Building materials were produced to individual needs of the people or the state. It was a craft-based cottage industry. Categorisation of slaves as given by the ancient lawgivers like Kautilya, Manu and Narada establishes the historic existence of slavery and bondage in ancient India; it refers largely to individual instances and not collective slavery other than when acquired as captives in wars and those who were referred to as dasas. During the Sultanate and Mughal periods, brick came back as a building material, though stones and wood were the predominant building material. A corollary to this discussion is that the ancient and medieval architectural styles did not demand innovations in the production of bricks on a large scale. Nevertheless, bricks were being produced on a smaller scale and as per demand by the Kumhars, the custodians of the technology of brickmaking and pottery. Kumhar is a caste, a part of the village community, but in the lower rungs of the caste hierarchy as they deal with clay and animal dung, the fuel. Major constructions during the imperial Sultanate and Mughal periods were not conducive for innovations in brickmaking as most of the constructions were stone-based. However, the situation changed drastically with the advent of the imperial British in India.

Section four deals with British imperialism in India, first by the

East India Company from 1613 and the British government from 1857, and their compulsions for innovations. British imperialism in India has been characterised as a civilising mission of the 'savage other'. Following Daniel R. Headrick's argument that certain technological innovations provided the necessary means to the motive of imperialism, the section elaborates on how the British started deploying science and technology into India by way of developing agriculture through controlling floods, setting up irrigation canals, opening coal mines, expanding telegraph networks and perfecting combat machineries. The construction of dak bungalows, garrisons, embankments of rivers and canals, and the building of railway networks required 'bricks' in large quantities and called for obtaining a large and uninterrupted supply of building materials, and consequently towards innovation in brick manufacturing. The production of bricks in large volumes required the mobilisation of raw materials, capital and labour, on a scale that was beyond the scope of small-scale brick production in India. The British did not bother to either develop indigenous technologies or bring in any technology in brickmaking. The changes that the British introduced in colonial India were innovations in the organisation of production of bricks, making brick production an industrial activity, which implied that the activities were ordered, rationalised and disciplined for mass production of bricks. It also introduced a division of labour where each worker was given different and specialised tasks to be carried out under supervision, as opposed to the undifferentiated activity of brick production by the Kumhars. The British further introduced a mechanism of sourcing workers that did not exist in brick manufacturing until then, by extending cash advances to lure workers through the agency of contractors/maistries/sardars/mukhadoms, whose control over the workers extended at the worksite too. Another important innovation had been the system of mobilisation of workers in units of varying sizes or gangs led by mukhadoms, sardars or maistries, who performed various tasks including obtaining workers, paying advances, commanding the members of the 'gangs' at the worksite, and receiving wages on behalf of the workers. Workers were mobilised along caste lines and deployed along caste lines to work as bonded labourers. Moreover, the imperial British managed not only the demand side of the labour market but also its supply side by creating conditions for the availability of vulnerable skilled and unskilled workers in large numbers in India's rural areas.

Section five, while elaborating on the brick industry in Britain in the 18th and 19th centuries, says that the elements of innovation – sourcing of workers and organisation of production – came in from Britain and continental Europe, where production largely happened in clamp kilns and all tasks from the digging of clay to the tempering up and moulding were done by the moulder and his family, who were paid by thousands of green bricks. The kiln men were organised into a guild, whose tasks also included transporting both the green and fired bricks and the carting of the fired bricks to the building site by a separate section of the guild. In Europe and Britain, brick kilns were usually small units nearer to the locations where demands existed, but capable of clustered operation in a clamp or a kiln to meet larger demands; brick-making work was a sub-contracted exercise; workers, mostly migrants, worked in gangs and the gang leader not only sourced workers but also controlled work at site and decided on distribution of wages; family labour – men, women and children – worked as brick-makers; working hours were long, going up to more than 12 hours a day; the activity of making of bricks was fragmented into various sequential steps and assigned to different groups of workers to rationalise production and improve productivity.

Imperialist British contractors and engineers imported to India the production techniques and organisation to meet the increasing demands for bricks in the country. However, its application was not straightforward. The fiscal, agrarian and industrial strategies of the imperial British in India made available impoverished people in large numbers to work in the kilns, and they were cajoled into working in the kilns in a work culture alien to the traditional brickmakers in India. The mobilisation strategies and deployment of labour in the kilns were carefully manoeuvred, accommodating the social and caste prejudices existing in India, and not disturbing them. In the 19th century Britain and in other countries of Europe, technological innovations were taking place in a frantic pace in the preparation of clay, moulding and burning of bricks. But the British civil servants and technologists, despite being on a 'civilising mission' in India, were not interested in importing those technologies and applying them in brick manufacturing in this country because they already had imported and adapted organisational and labour exploitation principles to extract labour power from the abundant labour here.

Section six elaborates how the imperial establishment continued to experiment with brickmaking processes that would reduce the power of workers and increase the efficiency of the kiln without compromising on the deployment of abundant cheap labour. The result was the invention of the Bull's trench kiln in Calcutta. Evidences suggest that the imperial government promoted the use of bull's trench kiln in their various construction activities. Bull's trench could have been quite advantageous to the British engineers and contractors. It was more fuel-efficient compared to the periodic kilns that were being used; required low initial investment compared to Hoffman's kiln; and assured greater volumes of bricks from the high-capacity kilns. Bull's adaptation did not alter, in any way, the clay preparation and moulding processes, which remained manual and labour-intensive as earlier. Consequently, the bull's trench kiln did not alter the labour sourcing, labour deployment or organising principles for the brick kiln. Rather, it did contribute in knocking down the organising possibilities for workers by further disintegrating and 'rationalising' work in the kiln. Bull's trench kiln 'split up the originally large firing gangs into less skilled loaders and unloaders and more skilled, but far less in numbers, firemen. Those who are working on mud are the menials; those associated with work with a semblance of trade are higher in the hierarchy; and those working on fire are at the highest level. A brahminical, casteist allocation of work crept into the brick kiln sector. We get a deadly mixture, when those doing clay preparation and moulding jobs in the kilns are sourced through payments of advances, against the repayments of which they had to work in the kilns under gang leaders. Worse still is the total disregard for the health of workers – men, women and children – who were exposed to dust, smoke, heat and polluting emissions. The bull's trench kiln worked because the Indians were expendable factors and were available in distress and in large numbers to work in the kilns.

J. John
23 December 2017

Caste-based Division of Labour in Brick Kilns

Though usually not publicly recognised by the industry, it is generally acknowledged that there exists a caste-based hierarchy in the organisation of production in the brick-kiln industry. Brickmaking involves a series of processes and the types of work are characterised by a caste hierarchy in terms of the level of work and deployment of labour in the following ascending order – preparation of the clay and moulding of bricks (Pathers); loading of bricks in the kiln (Bharaiwala); stacking of bricks in the kiln (Beldaar); removing ash or rabish from the bricks (Rabishwala); removing fired bricks from the kiln (Nikasi); and firemen (Jhokaiwala or Jalaiwala). The two extremes of the occupations are represented by the Pathers, who are predominantly from the SC (Dalit) category, and the firemen, who are from a higher caste category. This system of caste hierarchy is a characteristic of occupations in the brick-kiln industry. Besides them are the Munshi, who is more a representative of the management and always from a higher caste. Usually, a Pather will always remain a Pather and cannot aspire to be a fireman. This hierarchy reflects India's caste system – the so-called pure tasks are carried out by the higher castes and the impure ones by the lower castes in the hierarchy. Working directly with mud is considered to be an impure task in India's caste system.

Are brick kilns a reflection of the caste-based society, despite brick kilns being categorised as an industry? Those who do not subscribe to this way of organising work in brick kilns may counter-argue that caste is not specific to brick kilns, and that in almost all industries and service sectors in India, Dalits and those from lower castes may be found employed in lower-level jobs like 'cleaning'. Such arguments need to be refuted on two grounds. First, the argument is an excuse invoking a prevalent situation, a sort of a circular argument, in which caste-based employment in another context has not been scrutinised as to why it should be so. Second, the work conducted by the Dalits and Tribals in brick kilns – of preparing clay and moulding bricks – is among the core activities in the brick-kiln industry. There is also a tendency to deny caste-based division of labour by arguing that the division of labour is skill-based, which again is fallacious because specific skills have been attributed to specific caste groups. A related concern is the apparent technological perpetuity in the brick kilns. There is no evident drive from the entrepreneurs, the scientists, the consumers, or the trade unions to change the technological composition of the brick kilns. The impression that is generated is that the brick-kiln industry is content with the way in which bricks are produced – that is, by adopting a caste-based division of labour. Industry can be a change agent; it can change the social norms, particularly caste-based division of labourers in the Indian context. Industry can also succumb to the social norms – of caste-based division of labour – assimilating it into its organisation of production.

The question is whether there is a relationship between lack of technological innovations in brick kilns and it embracing a caste-based division of labour(ers). Are the defining characteristics of India's (and South Asia's) brick kilns – namely, caste-based hierarchical division of labour and bonded labour – in any way linked to the technology of production of bricks in practice here? A related question is what has prevented innovations in India's brick kilns and whether caste-based recruitment is a factor preventing adoption of other technologies in India despite these being universally adopted in the production of bricks. Such a problematic aspect was never subjected to scrutiny in India's context, probably because of the presumption that caste-based occupations and bonded labour are natural ingredients to the Indian brick-kiln industry, which is usually described as 'artisanal', 'informal', 'traditional', 'unorganised', etc. A corollary to this position is a presumption that 'the situation has been like this for decades, if not centuries,' as a BBC reporter (Humphrey Hawksley) described the situation of brick-kiln workers in Hyderabad in 2014. Secondly, it could be because of an ideologically coloured argument that technological changes cannot bring about changes in social relations. This paper interrogates a potential relationship between lack of innovations in India's brick-kiln production and the existence of caste-based division of labour.

General Observations on Brick Kilns in India

Roughly, 1.5 billion bricks are made worldwide every year. India is the world's second largest brick producer after China, with an estimated annual output of 700–800 million bricks. Chinese manufacturing is increasingly dominated by modern technologies with lower emissions than those encountered in India, the largest *artisanal producer* in the world. It is not easy to make an assessment of the total number of brick kilns in India, the total output and the number of workers engaged in these kilns. Inconsistencies in the information on brick kilns prevail in previous and current micro as well as macro studies.

For instance, a survey conducted in 1981–82 by the National Labour Institute found that there were about 10,000 large-sized brick kilns (producing on an average 45,000 bricks per day) in Ghaziabad, Faridabad and Delhi. During the same year, according to the statement of the All India Brick and Tiles Manufacturers' Federation, New Delhi, there were 22,000 brick kilns (Ghaziabad, Faridabad, Delhi together) with a workforce of nearly 30 lakh (three million). {Jayoti Gupta, 2003}. Uttar Pradesh Pollution Control Board gives a figure of only 18,395 brick kilns in the state (which had complied with its order of 01 May 2014) in its 77 districts, as on 16 June 2017[1].

Usually, the demand for bricks is assessed based on the growth or deceleration of the construction industry, and rightly so, since bricks are among the primary materials used in construction activities. The Indian economy, which has experienced strong growth in the past decade, is expected to grow at 8 per cent in the coming decade, despite setbacks after demonetisation[2], making it among the fastest growing economies of the world.[3]{Government of India, 2017} India Brand Equity Foundation[4] projects that the real estate contribution to India's GDP is estimated to increase to about 13 per cent by 2028.{IBEF, 2017} The IBEF report adds that by 2022 the real estate and construction sector (sub-sectors housing, retail, hospitality, and commercial) in India is expected to generate 75 million jobs and emerge as the largest employer in the country. In particular, the sector will contribute to meet the estimated urban housing shortage of 18.78 million and the rural housing shortage of 14.8 million as of 2015, which is expected to grow to 48.8 million during XII plan period (2012–2017). This optimism of the Government of India is shared by research institutes and the private sector. They hold that certain policies of the government are expected to hasten real estate development. The government has allowed FDI of up to 100 per cent for townships and settlements development projects; it plans to build 100 smart cities; under the Housing For All scheme, 6 crore houses are to be built in which 4 crore will be in rural areas and 2 crore in urban areas by 2022; and the Real Estate Bill was passed in March 2016 to establish a real estate regulatory authority for regulating and promoting the sector.{KPMG, 2015} It has also been pointed out that India will emerge as the fastest growing construction market in the world by 2030, overtaking China and countries such as Qatar[5].{Global and Oxford Economics, 2015} The consequent multiplication of the building stocks is expected to boost a continuous demand for building materials. Bricks are one of the most important walling materials used in India. Sameer Maithel calculates that "a 6.6 per cent annual growth rate in construction activity would increase the annual demand for walling materials to around 500 billion equivalent masonry unit by 2030." {Sameer Maithel, 2013}

Increase in demand for bricks will increase the number of brick-manufacturing units or brick kilns and consequently the number of workers engaged in the activity of brick manufacturing. However, there is never any clarity on the number of brick kilns in India or the number of workers engaged in the brick kilns.

The Technology of Brickmaking

Brick, a durable and versatile material for constructing houses and other buildings, is a human invention. Bricks have an innate flexibility that makes them easily adapted and refurbished for a variety of uses. Similarly, brickmaking is a

1 Pollution Control Board, U.P. (2017). District-wise updated status of identified brick Kilns in the State of U.P. in Compliance of the Order dated 01.05.2014 of Hon'ble High Court in PIL-20773/2014 Sumit Sing Vs State of U.P. & Others. Retrieved 23 August 2017, from http://uppcb.com/status_brick_kiln.htm. The Court had asked PCB to conduct a survey of all brick kilns in UP and ensure its order on pollution.

2 In a speech on the night of November 8, Prime Minister Narendra Modi declared the decision on demonetisation. The press release issued by the Reserve Bank of India clarified, "Government of India vide their Notification no. 2652 dated November 8, 2016, have withdrawn the Legal Tender status of Rs.500 and Rs.1,000 denominations of banknotes of the Mahatma Gandhi Series issued by the Reserve Bank of India till November 8, 2016. Prime Minister said that it was necessitated to tackle counterfeiting Indian banknotes, to effectively nullify black money hoarded in cash and curb funding of terrorism with fake notes."

3 Government of India's Economic Survey 2016-17 states: "During the boom years between 2003 and 2011, India's real GDP growth averaged 8.2 per cent, and exports grew at an annual rate of between 20 and 25 per cent (in real dollar terms, for goods and services). So, assume conservatively that India aims to grow at 8 per cent for the next decade and that that requires growth in exports of goods and services of 15 per cent, respectively."

4 India Brand Equity Foundation (IBEF) is a trust established by the Department of Commerce, Ministry of Commerce and Industry, Government of India, to promote and create international awareness of the 'Made in India' label in markets overseas and to facilitate dissemination of knowledge of Indian products and services. https://www.ibef.org/about-us.aspx

5 Global Construction 2030 by Global Construction Perspectives and Oxford Economics says that "India will add US$1 trillion to our global growth story for construction to 2030, and with a rate of growth almost double that of China over the period to 2020." See https://policy.ciob.org/wp-content/uploads/2016/06/GlobalConstruction2030_ExecutiveSummary_CIOB.pdf

technological invention to adapt clay or shale or clay-shale mixtures by burning, and firing in a kiln or oven to produce strength, hardness, and heat resistance to make small building units in the form of rectangular blocks. These are not recent inventions. The earliest evidence of the use of adobe for constructing houses in rectangular forms in the subcontinent dates to 7000 BC. Even today adobe is the most widely used material for construction with only minor changes in either the material processing or the methods of building. {T.N. Gupta, 1998} Then, where is the innovation in brick manufacturing?

Brickmaking can be broadly divided into two stages: one, the process of moulding bricks, and two, the process of firing bricks. In India, and for that matter, in the whole of South Asia, the moulding of the bricks takes place manually.

Pre-firing Processes

Material winning: Usually clay is mined from agricultural land or riverbed through mechanical or manual processes.

Tempering: The mined clay is mixed with additives and water and left to age for at least 8 to 12 hours. The clay is mixed manually with hands and feet or in motor-driven pug-mills into soft dough. In some cases, soft mud moulding machines are also used to mould green bricks.

Moulding: A lump of mixed dough is taken, rolled in sand and put into the mould made of wood or metal. Sand is used as a releasing agent from the moulds.

Drying: The green bricks are de-moulded into an open area that is levelled and devoid of any foreign materials. After 24 hours when the green bricks become leather-hard, they are stacked in various open patterns to ensure enough airflow to dry the bricks. Every two days they are turned over to facilitate uniform drying and prevent warping. After 1 week to 2 weeks, they are ready to be fired into the final shape.

Besides the above-mentioned soft-mud process, in extrusion process/wire-cut the clay is forced by an auger through a lubricated die to form a continuous column of stiff clay that can be 'faced' by roll-texturing, sand-blasting and pigment spraying to produce a range of textures and other aesthetic effects. The column is cut into bricks using tightly strung steel wires, and hence the alternative name 'wire-cut'.

In the pressing process, semi-dry clay is pressed into a mould box to produce a brick that is regular in size and shape with square edges.

Firing-based Types of Brickmaking Units in India

Usual discussions on types of kilns are largely derived from the way in which firing of bricks takes place in a kiln. The design of the kilns differs according to the technological application of firing of bricks. In India, brickmaking is typically a manual process. The type of brick kilns found in India are: (i) clamp kilns; (ii) fixed/moving chimney bull's trench kiln (FCBTK); (iii) natural-draught zigzag firing technology (zigzag ND); (iv) high/induced-draught zigzag kiln (zigzag HD); (v) vertical shaft brick kilns (VSBK); (vi) Hoffman's kiln; (vii) down-draught kiln (DDK); and (viii) tunnel kiln.{Greentech Knowledge Solutions and Swiss Agency for Development and Cooperation SDC, 2014}[6]

1. Clamp Kilns

The clamp is the most basic type of kiln since no permanent kiln structure is built. It consists essentially of a pile of green bricks interspersed with combustible material. The green bricks are generally piled up on a thin bed of fuel (usually in case of coal-fired clamps). Where spreading of fuel in thin bed is not possible (usually in the case of firewood fired clamps), tunnels are made through the base of the pile in order to feed the fuel. In an improved version of clamp, the outer walls are plastered (scoved) with mud to reduce the heat loss and is termed as a scove kiln. The other improvement is the Scotch kiln in which the base, fire tunnels and outer walls are permanently built with bricks. An important point to remember here is that *till the end of the 18th century bricks were almost exclusively fired in clamps.*

2. Fixed Chimney Bull's Trench Kiln (FCBTK)

Fixed chimney bull's trench kiln (FCBTK) is the most widely used brick-firing technology in India and other South Asian countries. It is a continuous, moving fire kiln in which the fire

6 In the description below, the author is largely using the description provided by Greentech Knowledge Solutions in the 'Factsheets about Brick Kilns in South an South East Asia' 2014.

is always burning and moving forward in the direction of air flow due to the draught provided by a chimney. The bricks are being warmed, fired and cooled simultaneously in different parts of the kiln. *It is a modified version of the bull's trench kiln*. Initially it had movable metal chimneys that were placed on the brick setting and were moved as the firing progressed. This technology was modified to the more efficient and less polluting fixed chimney bull's trench kiln. Subsequently, during the 1990s, there was a large-scale shift to fixed chimney bull's trench kilns due to a regulatory ban on use of moving chimney kilns in India.

3. Natural-Draught Zigzag Firing Kiln (Zig Zag ND)

This is a continuous, cross-draught, moving fire kiln in which the air flows in a zigzag path due to the draught provided by a chimney. *It has many similarities with the FCBTK technology*, the main difference being the zigzag air-flow path. The zigzag firing concept was first used in Buhrer kiln (patented in 1868). The concept was later used in Habla kilns. In India, Central Building Research Institute (CBRI) first introduced the zigzag firing technology based on induced draught (with the help of a fan) during the early 1970s.

4. High/Induced-Draught Zigzag Firing Kiln (Zig Zag HD)

This is a continuous, cross-draught, moving fire kiln in which the air flows in a zigzag path. The draught required for the air flow is provided by a fan.

5. Vertical Shaft Brick Kiln (VSBK)

This is a continuous, updraft, moving ware kiln in which the fire remains stationary while there is counter-current heat exchange between air (moving upward) and bricks (moving downward). The VSBK technology has evolved from the traditional up-draught kilns in rural China during the late 1950s. Since 1990, under different technology-transfer projects the technology has been transferred to several developing countries including India.

6. Hoffman's Kiln

Hoffman's kiln is a continuous, moving fire kiln in which the fire is always burning and moving forward through the bricks stacked in the circular, elliptical or rectangular-shaped closed circuit with an arched roof. The fire movement is caused by the draught provided by a chimney or a fan. Hoffman's kiln was developed and patented by Friedrich Hoffman in Germany in the year 1858. These kilns were once widely used in Europe for bricks, ceramics and lime production. The technology was introduced in India in the Malabar coastal region (south-west coast) by the German missionaries in 19th century and is still prevalent in the same region.

7. Tunnel kiln

Tunnel kiln is a continuous, moving ware kiln in which the clay products to be fired are passed on cars through a long horizontal tunnel. The firing of products occurs at the central part of the tunnel. The tunnel kiln is considered to be the most advanced brickmaking technology. The main advantages of tunnel kiln technology lie in its ability to fire a wide variety of clay products, better control over the firing process, and high quality of the products. The tunnel kiln technology was developed around the mid-19th century in Germany. However, the application of the technology for brick firing took place in the 20th century. After the Second World War, the technology was widely adopted and led to the transformation of the European brick industry from several thousand small and scattered brickmaking units into a few hundred large-scale and highly mechanised tunnel kiln units. In India, there are very few (~5) tunnel brick-kiln units.

8. Down-draught Kiln

The down-draught kiln is an intermittent kiln in which the bricks are fired in batches. In this kiln, the hot gases from the burning fuel are first deflected to the roof of the kiln and then are drawn downwards by the chimney draught through the green bricks to fire them. Till the end of 18th century, bricks were almost exclusively fired in freely stacked heaps of clamp kilns. However, in early 19th century, various technological modifications were tried aimed at improving the product quality and energy efficiency of the kilns. In the process, first up-draught and then the down-draught kilns were developed. One of the advantages of this kiln is that the fuel and fuel residue do not come into contact with the kiln charge and therefore no pollutants are deposited on the surface of the products.

The production processes of bricks are different in northern

Table 1: **Types and Scope of Brick Kilns in India**

Types and Scope of Brick Kilns in India					
Sl No.	**Types of Kilns based on Firing Technology**	**Number of Enterprises India**	**Total Production India (Billion Bricks)**	**Per cent Production in India**	**States where It Usually Occur**
1	Tunnel Kiln	5	0.08	0.03	Karnataka, Tamil Nadu, Haryana
2	Down-Draught Kiln	300	0.24	0.10	Karnataka
3	Natural Draught Zigzag	50	0.25	0.10	Uttar Pradesh, Bihar
4	Vertical Shaft Brick Kiln (VSBK)	110	0.3	0.12	Orissa, Jharkhand, Chhattisgarh, Madhya Pradesh
5	Hoffman's Kiln	500	2	0.81	Kerala, Tamil Nadu
6	High/Induced Draught Zigzag	2000	10	4.03	West Bengal
7	Clamp Kiln	1,00,000	50	20.17	Gujarat, Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu, Kerala
8	Fixed Chimney Bull's Trench Kiln (FCBTK)	35,000	185	74.64	Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Madhya Pradesh, Rajasthan, Tamil Nadu, Andhra Pradesh
	Total	137,965	247.87	100.00	

Source: Calculated from 'Greentech Knowledge Solutions & Swiss Agency for Development and Cooperation SDC. (2014). *Fact Sheets about Brick Kilns in South and South East Asia*. New Delhi: Greentech Knowledge Solutions Pvt. Ltd.'

mountainous region, Gangetic plain and peninsula (triangular plateau region) of India.[7] Nevertheless, there is predominance in the adoption of FCBTK technology, a derivative of bull's trench kiln, in the Indo-Gangetic plain stretching from Punjab in the west to Bengal in the east and extending to Pakistan in the west and to Bangladesh and beyond in the east. Of about the annual production of 247.87 billion bricks in India, about 75 per cent is accounted for from this region, specifically using FCBTK firing technology. {Sameer Maithel, 2013} {Development Alternatives, 2012}

Results from the Case Studies

The initial attempt was to test the hypothesis by conducting case studies of various types of kilns between the extremes of those using most archaic forms and those that are fully automated, presuming that the caste configuration in the kilns will change as the technology adopted by the brick kilns changes. Twenty case studies were conducted in Rajasthan, Uttar Pradesh and Haryana. The following types of kilns existing in India were chosen in the order of their technological finesse: (i) clamp kilns; (ii) fixed/moving chimney bull's trench kiln; (iii) down-draught/clamp kiln; and (iv) tunnel kiln.

Clamp kilns are the most traditional forms of brick kilns. Among 11 clamp kilns that were visited in the Bhilwara district of Rajasthan, nine were owned by people from the Kumhar community from Madhya Pradesh. The clamp kilns studied in the Bhilwara district of Rajasthan were owned by the Kumhars who were migrants from Ratlam and Mandsaur districts of Madhya Pradesh. The kilns required six to twenty workers to operate. Making bricks in a clamp kiln has been the

7 The brick production in the northern mountainous region is very low and is limited to valleys – e.g., Srinagar, Jammu and Dehradun. The Gangetic plains of north India account for about 65 per cent of total brick production. Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal are the major brick-producing states in this region. Brick kilns, generally of medium and large production capacities (2–10 million bricks per year), are located in clusters around major towns and cities. Peninsular and coastal India account for the remaining 35 per cent of brick production. In this region, bricks are produced in numerous small units (production capacities generally range from 0.1 to 3 million bricks per year). Gujarat, Orissa, Madhya Pradesh, Maharashtra, Karnataka and Tamil Nadu are important brick-producing states in the peninsular plateau and coastal India. {Development Alternatives, 2012} {Sameer Maithel, 2013}

traditional occupation of the Kumhars. In the kilns studied, the owner and other members of the family also worked together. They performed the task of setting up the place of firing the bricks where they had to arrange the sun-dried bricks and the fuel (wood and coal) in a batch. There was division of labour, but there was no division of labourers based on pure or impure work. The Pathers were getting Rs 400 per 1,000 bricks and the loaders were getting Rs 200 to Rs 250 per 1,000 bricks. The loaders worked as Pathers whenever there was a requirement inside the clamp. This was also the case with the job assignments for workers from the local community. The capacity of the batch of bricks in one firing cycle varied between 30,000 and 200,000 bricks in different clamp kilns. The clamp kilns in Rajasthan catered to the local market of Bhilwara. The selling price of the bricks from the clamp kilns were between Rs 3,200 and Rs 3,500 per 1,000 bricks.

Three bull's trench kilns in Rajasthan were running with the movable iron chimneys. The remaining six kilns (3 in U.P. and 3 in Rajasthan) were running with fixed chimneys. No differences were found in both types of brick kilns in terms of the scale of production, types of work involved in the brickmaking process, and the deployment of workers inside the kilns. However, the movable iron chimneys had to change every season and this involved a cost of Rs 50,000 every time. The investment required to set up a fixed chimney was around 15 to 20 lakh rupees and it was a one-time investment. The scale of production in these kilns varied from 12 lakh bricks to 1 crore bricks seasonally. The requirement of workers in one kiln varied from 50–60 to 100–150. The workers in these kilns worked as a family unit and the wages were calculated on a piece-rated system on the basis of work done by one family. Balaji Bricks, Lirdia, Mandal block, Bhilwara, Rajasthan, operating with a movable iron chimney, had a requirement of around 40 to 50 workers. The Pathers and Jalais were from Bandla and Chitrakoot in U.P. Pathers were from the Chamar caste and Jalais were Yadavs. The Bharai, Nikasi and Beldaars were Rauts (OBC) from Masooda. There were different contractors for different types of workers. Geeta Bricks, Bhilwara, Rajasthan, with a movable chimney, had a requirement of around 70 workers in the kiln. There were different contractors for different workers. The Pather workers were from Bihar; they were from the Maanjhi and Lahiya communities. The Jalai workers were Yadavs from Uttar Pradesh. The other workers were from Masooda in Rajasthan and were Rawats. Vinayak Bricks, Bhilwara, Rajasthan, another movable iron chimney brick kiln, had a requirement of 60 to 80 workers. The Pather workers were from U.P. and Bihar and were from the Maanjhi and Chamar communities. The Jalai workers were from U.P. and the rest of the workers were Rawats from Masooda in Rajasthan. In Shakti Bricks, Bhilwara, Rajasthan, operating with a FCBTK, the Pathers belonged to the Chamar, Maanjhi and Pasi communities of Uttar Pradesh and Bihar. The Bharai and Nikasi workers belonged to the Rawat community and the Jalai workers were from the Yadav community. The situation in other FCBTKs in Rajasthan and U.P. was similar. Pathers were from Chamar, Pasi and Lodhi communities. Overall, the bull's trench kilns operate on a much larger scale than the clamp kilns and the recruitment of labour is done through contractors. There is evidence of the workers being recruited on the basis of caste. Regional variations do exist in terms of deployment of workers; however, workers from the Dalit community are engaged in Patheri work and they do not have access to upward mobility in brick-kiln work.

In Bharat Bricks in Mohali, Punjab, a semi-mechanised kiln, the mixing of clay was done using the machines. However, the moulding of clay and the rest of the work, which was similar to the work in a bull's trench kiln, were done by Dalit workers from Uttar Pradesh and Bihar. The Jalai workers were from Pratapgarh in Uttar Pradesh. In Prayag Clay Products, Varanasi, a semi-mechanised brick kiln, the workers were largely operators of machines, the exceptions being the workers doing the loading and unloading work and the Jalai workers who were doing the work manually. The cleaners of the coal (before the coal was fed into the firing area) were women workers. The workers were a mix of Adivasis (ST) from Jharkhand and other backward classes from local areas. One of the Munshis was a Yadav (OBC) from the nearby village. The Jalai workers were Adivasis from Jharkhand. This was in contrast to the Jalai workers found in the other kilns who were mostly from the Pratapgarh area in Uttar Pradesh.

Bharat Bricks in Mohali, Punjab, is an automated tunnel kiln with a shed drying (bricks) system. The workers in these kilns were operators of the machines. The three workers who were interviewed were from the Saroj (Pasi) community and were Dalits. They were operating the machines where customised clay products were being designed.

Summary of Observations from the Initial Case Studies

The initial case studies showed that as technology of brick production picks up, the rigidity in caste-based deployment of labour eases. Higher the technology, higher were the

chances for Dalits and Adivasis getting into occupations not meant for them in the low-technology kilns. Nevertheless, the findings came with a rider. Clamp kilns owned and managed by Kumhars, the traditional brickmakers of India, did not have caste-based hierarchical division of labour; the hierarchical division of labour started with the bull's trench kiln. On the other side, caste based occupational rigidity did not necessarily disappear as the technology improved.

The Problem Redefined

The findings of the initial case studies compel us to look afresh at the problem – a potential relationship between lack of innovations in India's brick-kiln production and the existence of bonded labour and caste-based division of labour. Can the introduction of bull's trench kiln be termed a technological innovation? If so, why, when and how did it happen? Who were the innovators? What precisely are the elements of the innovation? How did regimented caste-based division of labour and bonded labour become the hallmarks of the bull's trench kiln? How did caste relate to India's brick kilns historically? How did it impact society? In the light of Headrick's postulation, if bull's trench kiln had been the means, what could have been the motives?

This we intend to explore first by looking into the inconsistencies in the information on brick kilns and its implications. Further, we will examine the theory of innovation to see how it can help us in understanding technological changes in brick manufacturing and its impact on the society. Importantly, since India's tryst with bricks began thousands of years ago in the Indus Valley civilisation, an effort will be made to understand historically the relationship between brick technology in India and social dimensions of its production relations. Further, we will scrutinise the historical context, the period of British imperialism in India, when the technological innovations were introduced in India, including the source of innovation and its application, how brick production has become an industrial activity, and the organisation of production, labour sourcing and deployment and the impact it had on Indian society.

Problems in Defining the Status of Brick Kilns

There is confusion regarding the status of the brick kilns in India. 'Artisanal', 'informal', 'traditional', 'unorganised' – these are the terms used to characterise brick kilns in India and for that matter for the whole of South Asia, a region stretching from Afghanistan to Bangladesh. This characterisation of the Indian brick industry is widespread among administrators, academics, architects, brick manufacturers and civil society organisations. Sameer Maithel, architect and specialist on brick-kiln technology[8], observes, "Indian brick industry is mainly unorganised and non-mechanised."{Sameer Maithel, 2013} {Sameer Maithel et al., 2014} This opinion is reflected in other studies like the one conducted among 6 districts in Bihar by Development Alternatives[9] {Development Alternatives, 2012} and in a scoping study for National Brick Mission by Centre for Science and Environment[10]. {D.D. Basu et al., 2016} In an article published in Economic and Political Weekly, Jayoti Gupta says, "brick kilns are located in *small-scale manufacturing units* on the outskirts of urban centres." {Jayoti Gupta, 2003}

In the National Industrial Classification (NCO 2008) Codes, construction as an industrial activity is grouped under 'Section F: Construction' (Codes 410–429), which cover 'general construction and specialised construction activities for buildings and civil engineering works'.[11] Brick kilns and enterprises manufacturing bricks are not included in this category. Instead, brick-manufacturing units have been grouped as '2392: manufacture of clay building materials"[12] under 'Division 23: manufacture of other non-metallic mineral

8 Greentech Knowledge Solutions is a Delhi-based clean energy research and advisory firm that offers services across renewable energy, energy efficiency, and green buildings domains.

9 "Brickmaking is a traditional, unorganised industry generally confined to rural and peri-urban areas," says the report. Development Alternatives is a social enterprise dedicated to sustainable development and a research and action organisation based in New Delhi. (http://www.devalt.org)

10 "Brick sector is a resource-intensive and highly polluting sector. It is largely unorganised and has never really come on the radar of regulatory agencies," says the report. The National Brick Mission (NBM) is a public interest research and advocacy organisation based in New Delhi and reportedly aims to transform the Indian brick sector by facilitating large-scale adoption of technologies for cleaner fired-brick production, finding alternatives to fired clay brick. (http://www.cseindia.org)

11 It includes new work, repair, additions and alterations, the erection of prefabricated buildings or structures on the site, and also construction of a temporary nature. It does not include manufacturing of bricks, though the production of bricks is for construction activities.

12 The industrial units include those engaged in 'manufacture of non-refractory ceramic pipes, conduits, guttering and pipe fittings, and manufacture of other clay building materials'.

product'. This falls within overall Section C: Manufacturing and covers 'manufacture of intermediate and final products from mined or quarried non-metallic minerals, such as sand, gravel, stone or clay'. Annual Survey of Industries (ASI) 2014–15 gives information on industries at four digits – manufacture of clay building materials, which includes manufacture of bricks and of non-refractory ceramic sanitary wares (sinks, baths, water-closet pans, flushing cistern etc.). There are a few important interrelated consequences of this official, academic and popular acceptance of this characterisation of brick kilns.

One, from an administrative perspective, brick kilns are allowed to operate in a grey area with respect to legal compliances, though the brick kilns are subjected to various laws and administrative regulations by various departments. The brick kilns are expected to obtain permission from the Revenue Department; clearance from the Pollution Control Board (PCB); registration with the Industry department either under Factory Act, 1948, or under Micro, Small & Medium Enterprises Development (MSMED) Act, 2006; and observe various labour laws.[13] Information provided by the UP Pollution Control Board reveals that 75 per cent (13,797) of 18,395 brick kilns registered in 68 districts of UP as on 15 June 2017 had not obtained approval from the department.[14] Similarly, information available with the Bihar State Mines Department acknowledges that as on 17 June 2016, of 6,801 brick kilns in the state, 32 per cent (2,173) had not made payments to the department, making their status illegal.[15] A report published by Action Aid in 2005 {Koy Thomson et al., 2005} reported that officially nearly 100 per cent of the brick kilns in Hyderabad are illegal. 'They simply did not have the licences to operate, or the necessary registration for migrant workers', and thereby escape various legal provisions as in Factory Act, Payment of Wages Act, Mines and Minerals Act, Provident Funds Act, Workmen's Compensation Act, etc.

Second, there is gross underestimations of the number of brick kilns operating in India. For instance, the Annual Survey of Industries (ASI) survey covers all factories registered under Section 2 m (i) and 2 m (ii) of the Factories Act, 1948 (employing more than 10 workers). Yet, the number ASI gives under NCO Code 2392 (inclusive of brick kilns) as 'factories in operation' is only 8,325, with an output of 966,582 units of products. This is a ridiculously low figure, when compared to the figures provided by A.K. Singh, vice president, All India Brick Manufacturers Association, claiming that there are around 150,000 registered kilns operational in the country {Anant Nath Singh, 2014} and producing 195 billion bricks annually and employing 200,00,000 workers. Ecobrick also gives an estimate of 150,000 brick units producing 170 billion bricks per year. {Ecobrick, 2012}

Third, brick kilns contribute to atmospheric, soil and water pollution. Central Pollution Control Board (CPCB) has recognised the brick-production industry as a highly resource- and energy-intensive and polluting industry *owing to prevalence of obsolete production technologies*. The global brick industry is a major source of carbon dioxide (CO2) emissions. A research report published by Carbon War Room and John Hopkins University says that from the coal consumed, the brick industry in the top five Asian brick-producing countries (India, China, Pakistan, Bangladesh and Vietnam) emits 1.2 per cent of total global anthropogenic CO2 emissions.[16] {Alexander Lopez, 2012}. In India, about 50 per cent of the total cost incurred on brickmaking is on fuel, and the brick sector is the third largest industrial consumer of coal after thermal power plants and iron and steel sector.{D.D. Basu et al., 2016} Combustion of coal and other biomass fuels in brick kilns results in the emissions of particulate matter

13 The applicable labour laws, even if registered under MSMED Act, include Bonded Labour System (Abolition) Act, 1976, Child Labour (Prohibition & Regulation) Act, 1986, The Contract Labour (Regulation & Abolition) Act, 1970, The Employees Provident Funds and Misc. Provisions Act, 1952, Equal Remuneration Act, 1976, The Factories Act, 1948, The Industrial Disputes Act, The Industrial Employment (Standing Orders) Act,1946, The Inter-state Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979, Maternity Benefit Act, 1961, The Minimum Wages Act, 1948, The Payment of Bonus Act, 1965, The Payment of Gratuity Act, 1972, The Payment of Wages Act, 1936, The Shops and Establishments Act, 1953, The Trade Union Act, 1926, Workmen's Compensation Act, 1923, etc. See http://dcmsme.gov.in/policies/lab_pol.htm

14 See district-wise updated status of identified brick kilns in the state of U.P. in compliance of the order dated 01.05.2014 of Hon'ble High Court in PIL-20773/2014 Sumit Sing Vs State of U.P. & Others. Retrieved 23 August 2017, from http://uppcb.com/status_brick_klin.htm.

15 See Mines & Geology Department (2016). Status of payments/action taken against illegal brick manufacturers for the brick season 2014–15. Retrieved 23 August 2017, from http://mines.bih.nic.in.

16 The report says, "Brick kilns are significant emitters of black carbon, which is known to contribute to climate change and local health problems. Black carbon and suspended particulate matter (SPM) are the second-largest contributors to global warming after CO2. More than 2.4 million premature deaths can be attributed to black carbon every year."

(PM), including black carbon (BC), sulphur dioxide (SO2), oxides of nitrogen (NOx), and carbon monoxide (CO). The emission of these pollutants has an adverse effect on the health of workers and vegetation around the kilns. {Sameer Maithel, 2012} {Sameer Maithel, 2013}

Fourth, brick kilns act as havens of 'bonded labour' and 'slave labour' in India. A BBC report {Humphrey Hawksley, 2014} based on observations from the cluster of brick kilns off Hyderabad, which employ migrant workers from Orissa, said India's brick-kiln workers 'live like slaves'. The report further said, "They work 12 to 18 hours a day, pregnant women, children, adolescent girls..." "Their diet is poor. There is no good water. They live like slaves." It adds that the *situation has been like this for decades, if not centuries*. Another report {Oliver Wainwright, 2014} says that India's urban boom is built on slave labour.[17] ILO includes bonded labour within its definition of forced labour.[18] A 2017 report published by the ILO says that of 40.3 million people in forced labour in the world, over half are held in debt bondage in both traditional forms of bonded labour and newer forms of debt bondage. {8.7Alliance, 2017} India with 18.3 million has the dubious distinction of having the highest number in modern slavery in 2016. {Walk Free Foundation, 2016} With changes in agrarian relations (from feudal to capitalist) in most parts of India, traditional forms of agrarian bondage have given way to modern forms of slavery in which is included bonded labour in brick kilns. {Centre for Education and Communication, 2004} {Nasir Ateeq and J John, 2003} {Ravi S. Srivastava, 2015}

Detailed mapping of brick kilns in Gujarat by Prayas Centre for Labour Research and Action in 2012 classified brick-kiln workers as bonded labourers. {Suneel Padale and Aditi Sinha, 2012} Similarly, based on an empirical observation of brick-kiln workers in Punjab, in light of the definition of slavery in UN Conventions, ILO Conventions on Forced Labour and the Indian law against bonded labour, John concluded that the status and the conditions of work in brick kilns corroborates the argument that workers are subjected to contemporary forms of slavery. {J John, 2014} There is broad concurrence among academics and practitioners on the key factors that make brick-kiln workers comparable to bonded labourers or bring them within the category of slavery, mostly based on the extent and intensity of vulnerability they experience as available and actual workers. (i) Brick-kiln workers are overwhelmingly migrant (inter-state or intra-state) workers from the poorest locations of the country; (ii) most of them belong to Scheduled Castes, Scheduled Tribes or Most Backward Castes; (iii) they are sourced by contractors against payment of advances and they work against those advances; (iv) they work extremely long hours – up to 16 hours a day; (v) they work as a family unit, with the men, women and children working, though women are never counted as independent workers as they are never in the muster roll; (vi) they are almost never compensated fully for the work and are forced to accept nominal wages based on records maintained unilaterally by the management; (vii) the working conditions are harsh and hazardous as they are exposed to the intense heat of the stove and are unprotected against extreme climatic conditions; (viii) they are made to live in difficult, unsafe, unhealthy and poor living conditions; (ix) they work against advances received and most workers accumulate debts that they are unlikely to pay up fully; (x) workers do not have the freedom to leave the job and choose another without settling the advances. {Ajita Banerjie, 2016} {Nalini Kant, 2006} {Vamsi Vakulabharanam, 2013} {Jayoti Gupta, 2003} {J John, 2014} {Koy Thomson et al., 2005}

Innovations and Their Impact on Society

There is no dearth of literature on *innovation* and a recent definition of innovation offered by the OECD says "an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." {OECD and Eurostat, 2005, #87060} The document further delineates *innovation activities* as those are scientific, technological,

17 Quoting Andrew Brady of Union Solidarity International (USI), a UK-based NGO, the report says: "Entire families of men, women and children are working for a pittance, up to 16 hours a day, in terrible conditions. There are horrific abuses of minimum wage rates and health and safety regulations, and it's often bonded labour, so they can't escape."

18 According to the ILO Forced Labour Convention, 1930 (No. 29), forced or compulsory labour is "all work or service which is exacted from any person under the threat of a penalty and for which the person has not offered himself or herself voluntarily." ILO clarifies that the 'forced labour' definition encompasses "traditional practices of forced labour, such as vestiges of slavery or slave-like practices, and various forms of debt bondage, as well as new forms of forced labour that have emerged in recent decades, such as human trafficking," also called 'modern-slavery', to shed light on working and living conditions contrary to human dignity.

organisational, financial and commercial steps that actually, or are intended to, lead to the implementation of innovations and types of innovations as (a) product innovation, (b) process innovation, (c) marketing innovation and (d) organisational innovation. The meaning and relevance of 'innovation' are understood linking it to a firm, market and consumers such that it is not only creative but must also be applied – whereby the application of practical tools and techniques makes changes, large and small, to products, process, and services and results in the introduction of something new for the organisation that adds value to customer and attributes to the knowledge store of the organisation." {David O'Sullivan and Lawrence Dooley, 2008, pp5}

Technological or scientific inventions, innovations and their applications contribute to economic and social change. The diffusion of innovations – among the society and among the innovators – could be incremental. However, technological changes – not only with respect to war time or nuclear innovations but also in the manufacturing sector – are considered a double-edged sword, which can bring benefits but at the same time pose serious challenges to economy, society and environment. {Isabella Massa, 2015} Among the types of innovations discussed above, product innovation – improving the quality and variety of products – is expected to lead to growth in employment, while process innovation – associated with reducing costs (capital and labour) – may reduce employment. {Mihaela DIACONU, 2011} Technology contributes to unemployment by displacing labour and making skill obsolete.{Andrew Robertson, 1981}[19] UNIDO proposes that the best way to approach social and policy implications of the application of an innovation is by assessing the economic, social and environmental trade-offs. There could also be many unintended consequences of applications of technological innovations in society – especially when those who believe in technology as an end in itself ignore the social and cultural norms of the society in which technology is being introduced. {Linda L. Naimi and Richard Mark French, 2009} Those who follow this functional approach conveniently miss the point that the applications of technology could be adapted to the social and cultural fabric of a society, if that allows for the continuation of domination of those who possess the knowledge of technological innovations.

In spite of the various attempts at defining what involves innovation, the original conceptualisation by Joseph A. Schumpeter in his seminal work *The theory of economic development*, published in 1934, remains relevant even today. Schumpeter argued that economic development is driven by innovation, which is defined as "doing things differently in the realm of economic life," and is activity or function of a particular set of individuals called entrepreneurs. {Paul M. Sweezy, 1943} According to Schumpeter's understanding, 'innovator' need not be the 'inventor' and an 'entrepreneur' need not be the 'owner' of a firm.[20] In Schumpeter's view, 'radical' innovations create major disruptive changes, whereas 'incremental' innovations continuously advance the process of change. Karol Śledzik observes that in the late thirties, Schumpeter begins to move away from his earlier theory of entrepreneurship, and presents a completely different one, where he says explicitly, that entrepreneur does not have to be one person. Schumpeter even states that the country itself, or its agenda, can act as an entrepreneur. {Karol Śledzik, 2013} Consequently, the author argues, Schumpeter categorically rejected the reduction of the economy to the abstract mathematical models, with total disregard for the institutional analysis and empirical studies, and history.

Approaching innovation from a historical perspective brings in dimensions of choice, and the use of scientific inventions and technology for domination and colonialism, and the discussion shifts from an enterprise-centric approach to the political and policy space. Here the interests of the enterprise(s) and the state merge with the objective of addressing a problem.

19 Anderson says that technology cannot be neutral. "Technology displaces labour, makes skill obsolete and contributes to unemployment. The 'human/technology relationship' has been examined in a book by M. Cooley, a British technologist who is also a trade-union official. In the quaintly titled *Architect or Bee*, ….Colley acknowledges that the successive waves of technological progress have in many cases freed human beings from routine, fatiguing, boring tasks, but too often and increasingly such progress has made some of them free to do nothing, their acquired skills and knowledge having been taken over by machines. Machines can work faster, more accurately in repetitive series of tasks, more consistently and smoothly than human operators and never get tired—though they may break down. The well-known result of this trend is that a highly skilled labour force (machine operators, setters, even toolmakers) is whittled down to the point where a handful of people watch control panels and another handful stand by for maintenance." pp. 436

20 Karol Śledzik (2013) in the article 'Schumpeter's view on innovation and entrepreneurship' quotes from Schumpeter, "The function of entrepreneurs is to reform or revolutionise the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganising an industry and so on."

In such situations – the adoption of a certain technology in the face of a 'problem' – is a matter of choice and the initial adoption of a certain, pervasive technology limits the subsequent choices of alternative technologies in the same area. {Werner Ackermann, 1981} In an article titled 'Why innovation theories makes no sense', Manfred Moldaschl argues that a theory of social innovation is not necessary, but rather a social theory which does not assume that state of equilibrium as the norm is needed as a starting point or even a goal. For understanding technical innovation, what is needed is not a theory of technology because 'technology does not produce itself'; "what is needed instead, is a *socio-economic theory* which provides a model of the synergies of the creativity of action, the economic incentives and the other institutional contextual conditions of producing technical artefacts (including the historical inventory of technical procedures)." {Manfred Moldaschl, 2010} These arguments – the need for understanding the application of technological innovation from a social, political and historical context – are relevant for the topic that we intend to discuss – the relationship between caste and technology in the brick kilns.

Daniel R. Headrick, historian of technology, offers an authentic historical exposition on the relationship between technological innovation and imperialism. The scope of his book 'Technology: A World History' (2009), though it does not discuss bricks, ranges from the Stone Age to the Industrial Revolution and the electronic revolution of the recent past; and it compares the evolution of technology in different parts of the world including India. However, more relevant to the current discussion are expositions in his books 'Power over Peoples: Technology, Environments, and Western Imperialism, 1400 to the Present' (2012) and 'The tools of empire: Technology and European imperialism in the nineteenth century' (1981). In Power over Peoples, Headrick describes the relationship between technological innovations and the European colonial conquests, a necessary and major role – in Africa and Asia during the New Imperialism[21]. In the former book, Headrick defines technology as "all the ways in which humans use the materials and energy in the environment for their own ends, beyond what they can do with their bodies"; and imperialism as "when a powerful state uses force or the threat of force to impose its will on a weaker society, especially when the weaker society belongs to another culture, we call that imperialism." He says the skewed distribution of technology helps those possessing technology to withhold it from them, or to use it against them. Establishing the relationship between technology and imperialism, as has been relevant for India, in The Tools of Empire, he says that European colonialists supplemented their *motive* to colonise with *means* – the key technologies of steamboats, steamships, rifles, quinine prophylaxis, and the telegraph – all of them products of the Industrial Revolution. Steamer and quinine prophylaxis represent the kind of 'technology that overcomes the obstacles of nature' and rifles, with the power of 'weapons and tactics'. Headrick gives an instance where one Captain Bertie-Clay of the Indian ammunition works at Dum Dum patented the mushrooming or 'dum-dum' bullet in 1897, a vicious invention that it 'tore great holes in the flesh'[22], perfecting the art of war. Incidentally, Calcutta has a place in the history of brickmaking too.

How are these discussions relevant to brick kilns, especially when we say that there had not been any technological improvements in brick kilns and when there are not any obvious connection between bricks and imperialism?

Brick Kilns and Social Relations in Ancient and Medieval India

In the absence of concrete evidences, it is difficult to conclusively state whether caste played a role and whether there had been bonded labour in the brick-manufacturing processes in India prior to British colonialism. Nevertheless, the discussion will be based on interpretations of available literature and deciphering the architectural relics of ancient and medieval India. Architecture is approached here not just as a cultural reflection, but also as a reflection of power

21 Headrick (2012) distinguishes between initial European expansion and the imperialist expansion. "The first phase in the expansion of Europe, often called the Old Empires, began in the early sixteenth century with the Spanish conquest of Mexico and Peru and the Portuguese domination of the Indian Ocean; by the beginning of the nineteenth century, however, Western efforts in China, Central Asia, Africa, and the Americas were running into diminishing returns. Then in the mid-nineteenth century came a renewed spurt of empire building—the New Imperialism—that lasted until the outbreak of World War II."

22 The book says that Europeans thought it too cruel to inflict upon one another, and used it only against Asians and Africans. Daniel R. Headrick. (1979) pp. 256

relations within society and nations.[23] {Monica Juneja, 2015} Such power relations or patronage relationships were interwoven within intricate patterns of authority – political power, ceremonial status and norms of etiquette – having a direct bearing on the patron's capacity to mobilise resources, including labour to erect such structures. Of relevance here is historical references to the 'relationship between patron, artist and architect, and those who were doing the actual building – brickmakers, stone cutters, masons, sculptors, calligraphers.' {Monica Juneja, 2015} pp. 49

Harappa and Mohenjo-daro

Architectural structures of India's ancient civilisation (*c.* 3000–1700 BC), one at par with Babylonian and Sumerian civilisations, was built on bricks. Stone being scarce and firewood in plenty, the Harappans built their city almost entirely in brick, both sun-baked and kiln-fired. That the firing was of high standard had been attested by the fact that the bricks survived intact, though underground, over thousands of years. Similarly, in Mohenjo-daro too excellent bricks, all of standardised dimensions, were used to build houses, roads and streets.{John Keay, 2010} pp. 31–33 No evidence has been given by archaeologists to indicate slave labour in the production of bricks during the period. History of bricks, as also the history of Harappan civilisation, take a break after 1700 BC.[24]

From 1500 to around 300 BC, during the Vedic and Puranic periods, when Aryans occupied the Indus and Gangetic plains as nomads and then pastoralists, there is little evidence of use of hard-baked clay bricks. What happened to the old technology is not known. Between 300 BC and 700 AD, the subcontinent appears to have witnessed a resurgence in construction with the ascendency of imperial Mauryas that continued right through the Gupta period, where burnt brick was used extensively in architectural structures. According to Taranath, Ashoka, the great Mauryan emperor, erected a temple and may be regarded as the founder of the Nalanda vihara, which were made of brick and the superstructures were supported on wooden beams. Since the imperial Mauryas, burnt brick and stone have been continuously in use as building materials in the alluvial plains of India. {T.N. Gupta, 1998} pp. 4 Towards eastern India, during the Pala dynasty (775 AD to 850 AD), Buddhist temple complexes were built in Bengal and Bangladesh.[25] {John Keay, 2010} Gupta opines that the building materials were produced to individual needs of the people or the state. It was a craft-based cottage industry. {T.N. Gupta, 1998} pp. 5

Slavery in Ancient India

Studies on slavery and bondage in ancient India points out existence of slavery. According to a reference in a Pali text, there are three categories of *dasa*s: (i) *dasa*s born in the house of the master (*antojato*); *dasa*s who are purchased (*dhanakhito*); and (iii) *dasa*s captured in war (*karamarantio*). Of the three categories, *dasa*s captured in war are likely to be historically significant in the origin of the institution of slavery. The Arthasastra (Kautilya's) devoted a separate section to rules regarding *dasa*s and *karmakara*s (labourers), and attempted to introduce some order and clarity as well as some measure of precision into the definition of the dasa status. The Arthasastra increased the number of *dasa* categories to provide nine separate types of *dasa*s: (i) persons captured in battle; (ii) *dasa*s born in the house of the master; (iii) those reduced to the status of *dasa* for food; (iv) those who were purchased; (v) *dasa*s who were received (as gifts); (vi) *dasa*s who were inherited; (vii) those reduced to the status of *dasa*s by judicial decree; (viii) *dasa*s who were mortgaged; and (ix) those who sold themselves as *dasa*s. Manu, writing later than Kautilya, outlined only seven categories of *dasa*s. They are: (i) persons captured in battle; (ii) those enslaved in return of food; (iii) *dasa*s born in the house of the master; (iv) those who are bought; (v) *dasa*s inherited as part of patrimony; (vi) *dasa*s who are given away by their parents; and (vii) persons

23 Monica Juneja in her edited volume, Architecture in Medieval India: Forms, Contexts and Histories says, "… the act of production, of bringing a structure or a complex into being, inscribes in its forms, spaces and textures its relation to the fundamental structures that, at a given moment and place, fashion the distribution of power as well as the organisation of society and economy. Building activity is as much a socio-administrative act: it involves the control of an apparatus necessary to plan and design, to mobilise resources and labour, to organise the quarrying and transportation of building material." pp. 5

24 John Keay says, "in the Indian subcontinent the first great experiment in urban living, in political organisation and in commercial enterprise disappeared without trace beneath the sand and the silt. In the land of reincarnation there was to be no rebirth for the bustling and ingenious world of the Harappans. History would have to begin again with a very different group of people."

25 John Keay says, "For the Palas were Buddhists, indeed the last major Indian dynasty to espouse Buddhism. Their lavish endowments included the revival of Nalanda's university and a colossal building programme at Somapura, now Paharpur in Bangladesh, where sprawling ruins and foundations, all of brick, attest 'the largest Buddhist buildings south of the Himalayas.' pp. 180

enslaved for not paying a fine or in execution of a judicial decree. Although debt bondsmen are missing in Manu's list, both Manu and Kautilya mentioned a new category which was that of a *dasa* who was reduced to this status in return for the acceptance of food. Both *dasa*s and *dasy*s were enemies of the Aryans, with whom they were in a perpetual state of conflict. The *dasa*s and *dasy*s were not identical, and the Aryans seemed to have followed a different policy towards each of them. The references to the *dasy*s describe their destruction (*dasyhara*), while there are no corresponding references to *dasahatya* – which indicates that the Aryans followed a policy of ruthless extermination toward the *dasy*s, whereas that for the dasas was tempered with moderation. {Uma Chakravarti, 1985} pp38. 43

Narada expanded the categories to take account of 15 different types of *dasa*s. The categories of slaves according to Narada's classification are: (a) *grihajata*, or the one born at his master's house of a female slave; (b) *kreeta*, or one purchased by the payment of a price; (c) *lubdha*, or one received (as a gift); (d) *dayadopaguta*, or the one obtained by inheritance (that is one who was the slave of the father or other ancestor; (e) *ankulabritta*, or one maintained during famine (that is one who during famine was saved from death in consideration of his becoming a slave; (f) *ahit*, or one who was pledged by his master (that is one who was made a pledge upon the acceptance of money by the master); (g) *rinadasa*, or one who was reduced to slavery by being freed from his debts; (h) *joodhprapta*, or one acquired as a captive in war; (i) *punajita*, or one won through a wager (one won after a stipulation 'in case I am defeated in this dispute, I shall become your slave'; (j) *oopagata*, or one who has offered himself saying "I am thine", that is, one voluntarily offering himself as a slave; (k) *prbrujeabusita*, or an apostate from asceticism (one who has swerved from the vow of asceticism); (l) *kritakala*, or one enslaved for a stipulated period (one made slave with the stipulation 'I shall be your slave for such a time'); (m) *bhuktadasa*, or one who has become a slave in order to get a maintenance (or one who has entered a perpetual state of slavery in lieu of maintenance); (n) *burrubabhritta*, or one led by a female (a female slave born in the house; one led by her out of a fancy for her; one who has married her and entered into slavery); (o) *atmavikrayee*, or the self-sold (one who sells himself).{Manjari Dingwaney, 1985}

While the categorisation as given by the ancient lawgivers, discussed in the previous paragraphs, establishes the historic existence of slavery and bonded slavery in India, it refers largely to individual instances and not collective slavery other than when acquired as captives in wars and those who were referred to as *dasa*s. It has been observed that Narada drew a clear distinction between *karmakara*s (non-slaves) and *dasa*s (slaves), wherein *karmakara*s could only be assigned pure work while *dasa*s had to do tasks that were looked upon as degrading and were officially termed impure work. Consequently, *dasa*s were expected to perform such impure work as plastering and sweeping the house, cleaning the doorway and rubbing the master's naked body with oil, clothing him, removing fragments of victuals left at his table, and so on. {D R Banaji, 1933} Though Narada did not directly equate *dasa*s with caste, he stated that Brahmins alone were not liable to incur the state of slavery under any circumstances[26]; read with Manu's prescription of caste[27], a link between caste and slavery could be drawn. However, since the technology of brickmaking from the Harappan civilisation was not being practised during this phase, and bricks were not being produced on a large scale, there is no reason to assume slavery in brickmaking, though it could have been the beginning of the emergence of a caste undertaking brick work in India.

Sultanate and Mughal Periods

In the architectural structures built during the period of Sultanate, which began with the ascendancy of Wutubuddin Aibak in 1192 AD, use of bricks along with stone and timber has been reported, though no evidences were found on large-

26 Banaji provides a quotation, "A Kshatriya or a Vaisya could likewise become a slave, in the inverse order of the classes, that is to masters of a class inferior to his own, provided he has forsaken his duty towards his own order." (quoted from Narada, Digest, B III, C.I.V. 56, Comments, pp. 254) (D.R. Banaji, 1933 pp. 208)

27 Uma Chakravarti explains, "The Shastra writers repeatedly reiterated the need for the varnashrama dharma, and condemned the practice of varnashamkara (mixing of the varnas), which implies that the prevailing social and economic stratification did not conform to the brahminical theory of ranking. ...Manu (in Dharmashastra) begins by asserting the orthodox view that the shudras were created by God to serve the brahmans, and he also enunciated the principle that slavery is the eternal destiny of the shudra. He believed that a shudra, whether or not he is bought, should be reduced to slavery because he had been created for the sole purpose of serving the brahman. He further states that a shudra could not be released from servitude because servitude is innate in him. He also postulated that members of the dvijas (twice-born castes) could not be reduced to slavery, and that anyone who compelled a dvija to work as a slave deserved to be fined heavily by the king." (Uma Chakravarti, 1985, pp. 51–52)

scale production of bricks. "Quwwat-ul-Islam mosque, near Qutub Minar, is one of the first structures of this period. ...the primary materials continued to be stone, brick and timber. {T.N. Gupta, 1998} pp. 6 & 7 But there are art historians who hold that as bricks were not available in sufficient quantities, the construction was mainly of stone.[28] However, during the Mughal Period beginning from 1526, though imposing architectural structures of palaces, forts, administrative structures, tombs and mosques – including Agra Fort by Akbar, Lal Quila and the Taj Mahal by Shajahan and the Moti Masjid by Aurangzeb – were erected in India, the dominant material in these constructions was stone (red sandstone and marble) that was quarried locally. For some reason, the use of clay brick declined in Sultanate and imperial Mughal constructions in the Indo-Gangetic plains. The case of temples and mosques in Bengal was different, where the building material was exclusively bricks, though there is no sufficient information on whether techniques of mass production of bricks were employed. {James Fergusson, 2015}[29] {Perween Hasan, 2015} A corollary to this discussion is that the ancient and medieval architectural styles did not demand innovations in the production of bricks on a large scale. Nevertheless, bricks were being produced on a smaller scale and as per demand by a caste, the Kumhars.

Kumhars – The Potters and Brickmakers

In India, traditionally, Kumhars are the custodians of the technology of brickmaking and pottery. Kumhar is a caste, a part of the village community, but in the lower rungs of the caste hierarchy as they deal with clay and animal dung, the fuel. They are variously called all over the country and W. Crooke (1896) in his anthology, 'The Tribes and Castes of North Western Provinces and Oudh (Volume III)' says that there could be "no less than 773 subdivisions of the Hindu and 52 of the Mohammedan branch."[30] W. Crooke observes that Kumhars are the brick-burners of the Panjab, and 'he alone understands the working of kilns.' pp. 339 Based on the Census Report for the Punjab, 1883, Government of Punjab published 'A Glossary of the Tribes and Castes of the Punjab and North-West Frontier Province' in 1911, which gives functional, cultural, religious and mythological explanations on Kumhars. It says that Kumhars could be Hindus or Sikhs or Mohammedans by religion. Kumhar is the potter and brick-burner of the country. Kumhar is described as a village menial, receiving customary dues, in exchange for which he supplies all earthen vessels needed for household use, and the earthenware pots used on the Persian wheel wherever that form of well gear is in vogue. He keeps donkeys, carries grain within the village area, brings to the village grain bought elsewhere by his clients for seed or food, and carries dust, manure, fuel and bricks. The report says that 'his social standing is very low, far below that of the Lobar and not very much above that of the Chamar; for his hereditary association with that impure beast the donkey, the animal sacred to Sitala, the small-pox goddess, pollutes him; as also his readiness to carry manure and sweepings.' It would appear that he makes bricks also when they are moulded; but the ordinary village brick of sun-dried earth is generally made by the coolie or Chamar. The production of bricks and pots by the Kumhar was a small-scale household operation. Risley in his report *Tribes and Castes of Bengal* (1891), referring to Kumhars in Dacca, observes, "The manufactory of the Kumhar well repays a visit. Beneath the same thatched roof are the kiln, storehouse, and dwelling-house, while at the door the clay is prepared. The kiln is called the *pan*, from the Sanskrit *pavana*, that

28 "The Turks who occupied Delhi came from areas in which both brick and stone were used in building, but architecture in brick, such as were in the oldest monuments of Bukhara, would have set the standard. Along with brick structures, the art of making tiles had been developed and was making continuous progress, both aesthetically and technically. On the other hand, sculpture and stone-masonry practised in the Greek colonies of Bactria and Gedrosia would not have died out. Thanks to Alauddin Jahansoz, we cannot now say whether Ghazni was mainly a city of brick or of stone or of wooden structures. But we may be certain that those who thought of building a mosque and a minar at Delhi were thinking in terms of architecture and not sculpture. Construction in wood was ruled out; bricks were not available; they could only build in stone." {Muhammad Mujeeb, 2015, #67109} pp. 292

29 Extracts from James Fergusson, *History of Indian and Eastern Architecture*, London, 1876, pp. 489–93, 557–68, reproduced as Chapter 1.2 in Monica Juneja (Ed.), *Architecture in Medieval India: Forms, Contexts and Histories*. He writes, "Bengal was early erected into a separate kingdom – in AD 1203 – more or less independent of the central power: and during its continuance – till AD 1573 – the capitals, Gaur and Maldah, were adorned with many splendid edifices. Generally these were in brick, and are now so overgrown by jungle as to be either ruined or barely invisible. They are singularly picturesque, however, and display all the features of a strongly-marked individuality of style." pp.123

30 Those of most local importance are the Badalna and Mehra of Saharanpur; the Baheliya, Baresra, Bharatduari, and Desi of Bulandshahr; the Bidaniya and Chakhri of Agra; the Dilliwal of Bareilly; the Baheliya of Budaun; the Gaur of Moradabad; the Gadhila of Shahjahanpur; the Bakhri, Chakhri, and Pundir of Bamla; the Kasauncha of Jaunpur; the Ajudhyabasi, Belkhariya, Dakkhinaha, Desi, and Sarwariya of Gorakhpur; the Birhariya and Dakkhinaha of Basti; the Bahraichiya and Daryabadi of Bahraich; and the Bam-puriya of Gonda. {W. Crooke, 1896, #82175} pp. 337

which purifies, and the hut, the *panghar*. The kiln is divided into compartments, in which the newly made vessels are arranged, earth being heaped over all. Wood is never used to heat it, but grass, reeds, or bamboo stems are the ordinary combustibles." pp. 525

In a functional relationship with the village community, there were no factors to motivate the Kumhars to innovate in either brickmaking or in the firing of bricks. There was only the passing on of the knowledge of firing of bricks from generation to generation. Major constructions during imperial Sultanate and Mughal periods were not conducive for innovations in brickmaking as most of the constructions were stone-based. However, the situation changed drastically with the advent of the imperial British in India. What are the factors that contributed to the change in the context? What were the technological innovations in brick kilns? What were the innovations? How did it impact the social fabric of the society?

To take the discussion forward, two issues are being highlighted. One, till the end of 18th century, bricks were almost exclusively fired in clamps and from there, it moved to the predominance of FCBTK. {Sameer Maithel, 2013} Second, as mentioned earlier, a continuous brick kiln was invented in 1857 in Germany by F.E. Hoffman. The first kiln had a circular, arched tunnel surrounding the chimney. Thirty years later, a British engineer, W. Bull, designed an arch-less version of Hoffman's kiln, which is now called bull's trench kiln. The bull's trench kiln is widely used in Pakistan, India, Bangladesh and Myanmar, but is little known elsewhere. {GATE} There must be a reason for the sudden change in the technology of brick-kiln production since the end of 18th century and the non-existence of bull's trench kiln in other parts of the world except Pakistan, India, Bangladesh and Myanmar. A historical analysis of the 'technological innovation' in the late 18th century of the bull's trench kiln will throw more light on the *motives* and the *means* of this innovation, as Headrick has argued.

Bricks, British Imperialism and Innovations

The British Empire in India lasted for nearly two hundred years since 1613 when the English East India Company (EIC), a royally chartered joint-stock company, received a permit from the Mughal emperor, Jahangir, to build a factory at Surat. Their empire building began with their victories in the battle of Plassey in 1757 against the Nawab of Bengal and the battle of Buxar in 1764 against the combined armies of Mir Qasim, the Nawab of Bengal; the Nawab of Awadh; and the Mughal Emperor Shah Alam II. Consequently, they obtained political control of Bengal Presidency. The British were formally granted revenue-collection rights in these areas in 1765. By 1860 a large part of the territories of modem India, Pakistan, and Bangladesh were part of the British Empire. There were also a large number of princely states in different parts of the country, all of which were under British political control but had autonomy in administrative matters. The rule of the East India Company came to an end after the Mutiny of 1857, when Indian troops revolted against their British officers. The revolt was suppressed, but the British government brought India under its direct control. Governance structure under EIC showed the duplicity of the British, where the political and economic interests merged. Government of India under Governor General in Council was headquartered at Calcutta with sub-units of Bombay Presidency, Madras Presidency and Bengal Presidency. Governor General reported to the Court of Directors of the EIC in London via the London-based India Office Secretariat. The Court, in turn, was subjected to the Parliamentary-established Board of Control where Chairman, a member of one of the houses of Parliament, was a member of the Cabinet of the Day. Through this link, Indian issues were reported to the Parliament, who had final authority over matters. {John Hurd and Ian J. Kerr, 2012} pp. 6

British imperialism in India has been characterised as a civilising mission of the 'savage other'. By the early 1790s, the British had put together a fundamental set of governing principles, which, based on Utilitarianism, included: security of private property, rule of law, and the idea of 'improvement' through imparting western education. {Thomas R. Metcalf, 1995} Differing from this perspective, there are those who consider British imperialism as despotic 'aimed at developing and exploiting the territory's resources efficiently and systematically,' {Gyan Prakash, 1999} and state that the British India was a garrison state manifesting 'the pervasive presence of the military within the decision-making process, the priority given to the military in terms of resource allocation... and the emphasis placed on using the threat or application (usually in a very public way) of military force as a means of securing political and strategic objectives' {Douglas M. Peers, 2007}. Following Daniel R. Headrick's argument that certain technological innovations provided the necessary means to the motive of imperialism, it is important to

emphasis here that the British started deploying science and technology into India by way of developing agriculture by controlling floods, setting up irrigation canals, opening coal mines, expanding telegraph networks and perfecting combat machineries.

These activities, especially the construction of dak bungalows, garrisons, embankments of rivers, canal construction and building of railway network required 'bricks' in large quantities and called for obtaining a large and uninterrupted supply of building materials, and consequently for innovation in brick manufacturing, the essential building material. The following section deals with how this demand for bricks was addressed, applying innovation of which nature, and how the transfer and application of technologies, though incomplete, were instrumental in transferring wealth from India and in consolidating the despotic political power in India.[31] {Gyan Prakash, 1999}

Irrigation Canals in British India and Requirement of Bricks

Imperial British embarked upon construction of a large network of irrigation canals, which on a policy level was simultaneously linked with famine prevention, revenue stability, the settling of unruly tribals, expansion of cultivation of cash crops, enhanced taxable capacity, improved cultivation practices, and political stability. Bricks were the essential component of irrigation canal construction.[32] The brickmaking alone for the Solani aqueduct kept 3,500 labourers occupied for seven to eight months a year over five years. To illustrate, Ian Stone (2012) writes in *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Society*:

"The construction and operation of large canal schemes entailed the mobilisation of substantial human and physical resources. During the construction phase, skilled workers had to be recruited, building materials gathered or directly manufactured, and armies of labourers assembled. By 1920s, close to 2,000 miles of main channels and more than 14,000 miles of state-built distributaries and other channels had been excavated in the UP, many of which of course were in cuttings or embanked for part of their length. Some of this excavation took place in relatively remote areas, such as the upper sections of Ganges Canal, including the construction of the numerous headworks installation, falls, weirs, and aqueducts. An executive engineer, of which there were six (one for each division) on the Ganges Canal, might easily have 5,000 men and hundreds of carts working daily on his section of construction. The brickmaking alone for the Solani aqueduct kept 3,500 labourers occupied for seven to eight months a year over five years. The actual construction work kept 2,750 employed for a full six years. pp. 57

...Thus, on the Ganges Canal, for example, one executive engineer and two assistants were occupied solely in organising materials. This principally involved brick- and lime-making on a huge scale, and the purchase (and often the personal selection) of timber from local forests. All engineers, in fact, who joined the service in the early days were required to learn how to make bricks by means of a simple trench-kiln system, and how to manufacture lime from kunker deposits found in the plains. This lime, when mixed with white lime and brick dust, conveniently possessed sufficient tensile strength to meet most irrigation requirements. While it continued to be usual for engineers to make small numbers of bricks as required, contractors did come forward to supply bricks for later works. The brick burning for the remodelling of the headworks at Myapur in 1882 was done, for example, by a large European firm." pp. 59–60

The Making of Indian Railways and the Requirement of Bricks

Since 1850, the British embarked on building a railway network in India. Governor General Lord Dalhousie in a memorandum dated 20 April 1853 recommended the development of a pan-India system of trunk lines connecting

31 Gyan Prakash in *Another Reason: Science and the Imagination of Modern India* says, "European ideologues of colonialism were conscious of the paradox of practising despotism in order to project the ideals of freedom, but there was nothing they could do to close the deep internal rift in their discourses. Compelled to use universal reason as a particular means of rule, the British positioned modernity in colonial India as an uncanny double, not a copy, of the European original – it was almost the same, but not quite. In the colonial context the universal claims of science always had to be represented, imposed, and translated into other terms. This was not because Western culture was difficult to reproduce, but because it was dislocated by its functioning as a form of alien power and thus was forced to adopt other guises and languages. Science had to be tropicalised, brought down to the level of natives and even forced upon them, so the argument went, if Britain was to do its work in India."

32 As with any technology, canal irrigation was not 'neutral' in its effects. It was intended to serve the perceived interests of its masters, in much the same way as the earlier irrigation works were. {Ian Stone, 2002, #90544}

centres of political, economic and strategic interests, linking Calcutta–Delhi–Madras–Bombay–North–West Frontier Provinces. As in the case of canal irrigation, it was not just the development of Indians in the mind of Dalhousie. In a letter, Dalhousie elaborated the benefits the railway network would bring to colonial Britain in political, military and economic terms.[33] So fast was the implementation that by 1870 trains ran over a railway network encompassing 6,541 route miles. The network grew to an impressive 23,627 miles by March 1900, at which time an extensive network of trunk lines and many branch lines criss-crossed the subcontinent. {Ian J. Kerr, 1995}

Construction of railways also raises the issues of technological innovations, technology transfer and technology diffusion, particularly in the context of imperialist expansion – the context of the ruler and the ruled. India did not have the technology; it necessitated the transfer of railway technology from Britain to colonial India. Technology included capacity to lay railway lines, preparation of rail beds, building of tunnels and small culverts and large bridges, manufacture of rails, plates and, over and above all, locomotives. Though the quality of rail construction was superior to what United States carried out at the same time, imperial Indian government imported from Britain necessary manufactured products such as rails, sleepers, prefabricated bridges, and locomotive engines. {Amit K. Sharma, 2011} Daniel R. Headrick observes that the rail development in the US and Western Europe provided impetus for the growth of iron and machine-building industries and employment. But this did not happen in the case of India. "Despite its impressive rail-road network, India remained underdeveloped well into the twentieth century."[34] {Daniel R. Headrick, 2009} pp. 107–108

As in the case of irrigation canals, railway building in India – in constructing bridges, culverts, station buildings and workshops – generated an enormous demand for bricks and a very large number of workers to make those bricks, a situation that was not experienced in India's previous history. Ian Kerr observes that an inadequate supply of bricks was a cause of delay in the building of the Eastern India Railway (EIR) in Bengal and the North-Western Provinces. The enormous requirement of bricks could be seen from the following examples. In the 17 miles of the Hullohar division of the EIR in the last half of 1858, 2,000,000 bricks were burnt, 4,500,000 were in the kilns ready for firing, and another 7,000,000 were moulded but not kiln-loaded for the lack of labour. {Ian J. Kerr, 1995, #86573} (Quoted from IOL&R, P/PWD/3/58, Bengal RR Letters, No. 30 of 1859, dated 19 May 1859. The footnote 50 also says that 7.5 million bricks were made in the Monghyr division during the same period. The Dufferin bridge required 1,876,289 cubic feet of brickwork; Walton, MPICE, 101 [1890], p 21.) It can safely be assumed that the production of bricks was in clamps since the period under discussion is from 1850 to 1900 and no alternative to clamps was available during the period.

Innovations in the Organisation of Production of Bricks

Here is a situation that calls forth innovation in the brickmaking technology and in the organisation of production of bricks. Technological innovation was called for because India's brick-kiln technology practised through generations by the Kumhar community was not studied and adapted to produce bricks in precise quality and dimensions required for the railways. Railway engineers held that the traditional Indian processes tended to turn out bricks that were badly tempered, badly shaped and often cracked. Moreover, the production of bricks in large volumes required the mobilisation of raw

33 'Immeasurable' advantages, writes Dalhousie, would accrue to a colonial administration composed of a 'comparative handful' of British administrators and soldiers scattered over the subcontinent. Railway would enable Britain 'to bring the main bulk of its military strength to bear upon any given point in as many days as it would now require months, and to an extent which at present is physically impossible.' The 'commercial and social advantage' of railways also received prominent mention. These included an increase in trade between India and Britain: and more Indian produce would be transported to Britain and more manufactured British goods would be sold in India. Railways would encourage enterprise, multiply production, facilitate the discovery of latent resources, increasing national wealth and encourage 'progress in social development' similar to that which occurred in Europe and the USA. John Hurd & Ian J. Kerr. (2012). *India's Railway History: A Research Handbook*. Leiden. Boston: Brill. pp. 9–10

34 Daniel R. Headrick compares the railway development in India and Japan. "It is instructive to contrast the Japanese railways with those of India in the same period. In 1890, Japan had 1,000 miles of railroads compared to India's 17,000; 40 years later, Japan had 16,000 miles to India's 44,000. Yet, because India was a colony of Great Britain, all the engineers and almost all its rails and equipment were imported from Britain." He further quotes from a report of a committee that investigated the railroads in 1921: "At the date of the last report there were employed on the railways of India about 710,000 persons; of these, roughly 700,000 were Indians and only 7,000 Europeans, a proportion of just 1 per cent. But the 7,000 were like a thin film of oil on top of a glass of water, resting upon but hardly mixing with the 700,000 below. None of the highest posts are occupied by Indians…"

materials, capital and labour on a scale that was beyond the scope of small-scale brick production in India. As has been observed, development of indigenous technologies was not a part of the colonial civilising mission. As would be explained subsequently in this paper, the British did not bother to bring in any technology in the brickmaking. Substantive changes that the British introduced in colonial India were innovations in the organisation of production of bricks. Ian J. Kerr observes that establishing an effective brickmaking operation, therefore, was one of the first important tasks an engineer undertook as he began to supervise the construction of a bridge, a section of line, or a building. The heavy demand for good bricks stimulated and rationalised brickmaking in India by way of introducing innovations in the organisation of production. These innovations primarily were in the management of operations, sourcing of labour and their deployment of labour in the actual production of bricks. The brickmaking units, clamps, were not permanent structures, erected for a particular construction activity, and dismantled after the work was over.

To illustrate, let us quote extensively from Ian J. Kerr (1995) on the brickmaking associated with Bombay Baroda & Central India Railway (BB&CIR) construction.

> "Detailed instructions for brick and mortar making were provided to the engineers and overseers of the BB&CIR in 1858. Appropriate deposits of clay and supplies of water first had to be located, near to which some two acres had to be obtained to develop a brickyard capable of turning out 25,000 bricks a day. Two pug mills driven by bullocks, in which the clay was mixed with water and kneaded to a dough-like consistency, and a shed of some 12,000 square feet for the moulders, had to be established. Three kilns, each with a capacity of 100,000 bricks, were needed for a brickyard of this size. The labour-force consisted of:
>
> - 25 moulders
> - 25 attendants to carry the bricks from the drying floor – boys paid at the women's earthwork rate were the best
> - 13 strong men with barrows, paid higher than earth-workers, to remove the bricks from the drying floor
> - 37 men mixing clay and wheeling it to the pug mills
> - 13 men or women wheeling clay from the pug mills to the moulders
> - 20 men to fill the kilns
> - 20 men to clean and burn kilns
> - 5 extras
>
> Other people, often working under petty contractors, were needed to supply the firewood and clay, and to cart the finished bricks to the worksites. Brass moulds, which again might be supplied under contract to British design and satisfaction, were preferable to traditional Indian wooden moulds, although the first Indian moulders resisted their introduction because of their weight and difficulty in getting the brick to come off the mould. This resistance, however, was overcome because brickmaking was piece work and the brass moulds, once mastered, enabled the moulder to turn out more bricks per day. Put another way, the labourer was co-opted into the creation of more surplus value for the employer. pp. 144
>
> Precise instructions were given as to how the moulders should sit and work, how the bricks should be stacked, when the hardened bricks should be moved from the shed to the back lanes, and then on to kin filling, kiln firing, and kiln emptying. The instructions stress precision and the need to maintain neatness, order, and strict discipline in the backyard. Fines were suggested for failure to follow procedures. The whole discussion, in fact, is redolent with the vocabulary of the discipline of factory work. The overseers had to manage the coolies carefully because if 'every department be not kept to its work, another department will feel it at once…' Tight schedules were to be maintained to meet the daily output of 25,000 bricks. Twenty men took 5 days to fill a kiln ready for firing, the burn took 4 days, cooling 6 days and then the cart-men needed 4 days to empty a kiln – thus one of these kilns can be fired every 22 days, allowing 2 Sundays and one cleaning-out day. No doubt the reality was a good deal less tidy, but nonetheless the aim of the BB&CIR's (Bombay, Baroda and Central India Railway) engineers was clear. Brick production was to be an industrial activity: ordered, rationalised, disciplined, with each worker doing his specialised task according to tight, supervised specifications to enable the 'factory' to produce its quota of bricks within the specified time." {Ian J. Kerr, 1995} pp. 145

Brick production in India was becoming an industrial activity, which implied that the activities were ordered, rationalised

and disciplined for mass production of bricks. It also entailed another important dimension – division of labour where each worker was given different and specialised tasks to be carried out under supervision as opposed to the undifferentiated activity of brick production by the Kumhars[35]. It is important to note that the innovations in the organisation of production and the division of labour as introduced by the British in their railway lines and canal constructions stayed on during the colonial period and even after that. This was not the case regarding minimalist innovations in brickmaking introduced by the British. With respect to brickmaking, the major innovations were in the introduction of bullock-driven pug mills to prepare the clay and the introduction of brass moulds instead of traditional Indian wooden moulds to mould bricks. Mechanical clay preparation and extrusion processes are less widespread even now. So is the case of brass moulds. Those did not survive to be used by the brick kilns all over the country as methods of moulding bricks. What had survived were the innovations in the sourcing of workers to work in the kilns and the piece-rate system of wages through 'gangers' and division of labour as they get deployed in the kilns.

Innovations in the Sourcing of Workers in Brick Kilns

During the period under discussion, the demand for workers was at an unprecedented scale and the workers that they had to source were a new set of workers, who were not traditionally involved in brickmaking. The Britishers appeared to have introduced a mechanism of sourcing workers that did not exist in brick manufacturing until then, by extending cash advances to lure workers through the agency of contractors/maistries/sardars/mukhadoms, whose control over the workers extended at the worksite too.

Advances as a Means to Lure Workers

Ian J. Kerr (1995) narrates the difficulties the British administration and their imperial contractors faced in obtaining workers for the railway construction and the adopting of payment of advances as a means to lure workers. A case in point is the construction of the 110-mile EBR from Calcutta (Sealdah) to Kushtia on the Ganges, the contract of which was awarded to Brassey, Paxton, Wythes and Henfry, established contractors from Britain, dated 31 December 1858, for the sum of UK Pound 1,045,000[36]. Henfry's letter reveals not only the difficulty in getting workers at low rates but also the fact that *contractors* were engaged by the British to lure workers for various public works like the construction of Eastern India Railway (EIR), the Calcutta and South-Eastern line, extensive government public works on the Calcutta circular canal, the rectification of the course of the river Matabhanga, and works connected with the Calcutta drainage, etc.[37] Henfry writes, "We soon found that if we did not follow the example of our neighbours, and tacitly sanction the system, we should get no Coolies, but such as resided in the villages in the immediate vicinity of the Line, who had not been previously accustomed to heavy works."[38] He refers to the practice of luring the workers by extending advances through middlemen. The Britishers engaged Indian subcontractors, who in turn engaged maistries/sardars/mukhadoms to obtain workers from far-off places by extending cash advances. Ian J. Kerr writes, "… from the perspective of the workers, the advance filled many functions. It could represent the cash necessary to enable workers to travel to a worksite; it could, if advanced further ahead in time, present the amount needed to tide a family over the unemployment of a rainy season; it could, at the point where a landless labourer or village servant was first inducted into the life of a circulating labour, represent the amount necessary to free the labourer from debt and other bonds to village power-holders; it could represent a mixture of all of these and other functions. The advance usually represented a considerable command of the person who gave it, over the labour of the construction worker. The advances helped to obtain and retain labour."[39] As has been observed in the previous section, bonded labour – working against a debt received in cash or kind – existed in India, but in an

35 Traditionally, same people from the community engaged in moulding of bricks, stacking and firing of bricks.

36 Work began in 1859 and line was opened for traffic in November 1862. {Ian J. Kerr, 1995, #86573} pp. 50 Source: Footnote 21 says that the material comes from IOL&R, L/PWD/3/62, Bengal RR Letters, No. 42, dated 25 June 1863. The particular document in question is Brassey, Paxton, Wythes & Co to W. Purdon dated 19 February 1863 in which they set out their final accounts, explain why it cost so much more than estimated, and ask for some response.

37 ibid. pp. 50

38 ibid. pp. 51

39 ibid. pp. 118

agrarian and domestic set-up. The imperial British adopts that practice, and universalises and institutionalises it in an industrial and general labour market set-up.

Operation in Gangs and the Phenomenon of Gangers

Another important innovation had been the system of mobilisation of workers and their deployment on to the railway construction sites and working at the sites in units of varying sizes or *gangs*. Ian J. Kerr uses the term *gangers*, which he obtained from the colonial records, to describe the leader of the units, distinct from the members of the gangs. *Gangers* were mukhadoms, sardars or maistries and they performed various tasks. One, they made advances to workers and obtained them in each season: "There is no local labour and therefore the difficulty of collecting and organising the workmen had to be commenced almost afresh after each rainy season. This was effected by sending numbers of maistries and mukhadoms corresponding to foremen and gangers to the different towns and villages in a circuit of 200 or 300 miles supplied with money to enable them to advance small sums merely sufficient to keep the men on the road. The labourers thus collected were taken to the nearest railway station on the Concan or Deccan where their fares were paid for them to Khandalla or Campoolee at the top or the foot of the Ghat as the case might be."[40] Two, the 'gangers' commanded the members of the 'gangs' at the worksite.[41] Three, workers received wages through the 'gangers' after allowing them to take a cut.[42] British imperialists used advances as an enticement to attract workers to their construction sites and related activities including brick kilns. Deployment of gangers and the instrumentality of advances, however, ensured that the workers were not going to the worksites of their own volition to sell their labour power as 'free' individuals, but as bonded labour who had to expend their labour power against the advance received.

Caste-based Gangs

There was an additional factor that made the power of the 'gangers' and the contractors over the workers mostly 'despotic' in nature. The British colonial power particularly used caste and kinship structures in India to ensure a regular supply of workers to work in their capitalist construction enterprises and related activities. The 'gangers' obtained workers from the same or nearby village of his own, or of the same caste or kinship 'that facilitated the act of recruitment and helped to ensure the security of the advance.'[43] The 'gangers' commanded the workers at the worksite, received wages on behalf of the workers, and took a share of wages as their profit. The British contractors allowed caste prejudices to continue in their worksites without not just questioning them but in fact using them as a means of control. A contractor had reported to have said that the skilled workmen had 'innumerable and most absurd prejudices' and were divided into castes who would only do a particular kind of work and who would not work with men of another caste.[44] The unskilled workers came overwhelmingly from the lower reaches of the Indian society where people took up many forms of work in the desperate search for survival.

Bonded Labour in Kilns

In a way, the imperialists went a few steps ahead disciplining workers and extracting surplus labour. The imperialists needed labour—labour in huge numbers—and they obtained them forcefully and deceptively. The traditional brickmakers in India would not have been available in the numbers or the Britishers only needed workers seasonally, ones who could be trained on the job as the work had already been fragmented distinct from

40 ibid. pp. 120. (Quoted from Graham, ICE MS no.1161) The note of the author adds: C.B. Ker and R.W. Graham, who had served as CEs of the Great Indian Peninsular Railway (GIPR), became contractors' agents. (pp. 82). A late nineteenth century description can be found in Spring, Technical papers No.71, p54. ICEMS No.1161, R.W. Graham, 'Description of the Bhore and Thule Ghar Inclines', GIPR, 1866

41 Ian J. Kerr (1995) writes, "…The gangers, variously styled muccadum, sardar or maistry, were the ones who made advances to workers in order to persuade them to come to the work sites. The same people usually commanded the gangs at the work sites, although the engineers sometimes tried to enhance their direct control of work by placing men of their choice in charge." pp. 119

42 Ian J. Kerr (1995) writes, "Brunton refers to men working in groups under self-elected muccadums or gangers who made all arrangements for work, who received and divided the groups' earnings, and to whom each worker paid a percentage of his wages." (Brunton, MPICE, 22 (1862–3), p. 457). John Brunton was the CE of the Sind, Punjab and Delhi Railway (SP&DR). The author quotes from *John Brunton's Book, Being the Memories of John Brunton, Engineer*, from a manuscript in his own hand written for his grandchildren and now printed. With an Introduction by J. H. Clapham. Cambridge. Cambridge University Press. 1939.

43 ibid. pp. 119

44 Ian J. Kerr, (1995) pp. 115 Quoted from IOL&R, Eur MSS. C. 401, Two letters, dated 1851, from Henry Fowler (1821–54), Fowler to Leather dated 2 May 1851, Bombay.

the practice of Kumhars. The imperialists nurtured a group of people as mukhadoms as a key element of 'unusual exertions'[45] and sent them out to villages to fetch people to work in the kilns and other construction activities. Mukhadoms were entrusted with cash to be given to prospective workers as advance wages to entice them to come to the worksite. One will have to seriously ask the question whether this is actually the beginning of bonded labour in brick kilns, when there are no convincing evidences to suggest that brick kilns till then had operated on a commercial basis employing wage labourers. Praedial and domestic bonded labour would have existed in India and it would be far-fetched to infer that the recruits were such people saved from bondage; mukhadoms were on a mission to entice workers by giving them advances. Workers' gradual movement to the status of bonded labourers would have been easier given the fact that the workers had to work against advances and there was no mechanism to prevent them from slipping into bondage. Moreover, the imperialists were emboldened by legal provisions that in a way legalised bondage or labour against advances and contract labour. The Workman's Breach of Contract (13 of 1859) was designed to provide for the breaches of contract by artificers, workers and labourers, and it emboldened employers to keep labourers in virtual bondage under the threat of imprisonment. This law came after the abolition of slavery in India by Act V of 1843 by the imperial government, which covered the category of slaves within its purview and ignored the categories of bondsmen and contract labour. {Manjari Dingwaney, 1985}

Why were the workers available to be lured in this way? From where did the workers come from? The imperial British not only managed the demand side of the labour market but also its supply side by creating conditions for the availability of vulnerable skilled and unskilled workers in large numbers in India's rural areas.

Rural Impoverishment and Management of Supply

Various research studies and colonial reports have shown the prevalence of extreme poverty and vulnerability that the rural population in the Indo-Gangetic plains experienced during the period of British colonialism. {Elizabeth Whitcombe, 1972} {Elizabeth Whitcombe, 1993} {Giorgio SHANI, 2006} {Gyan Prakash, 1990} {Krishna G. Karmakar, 2015} {Thomas R. Metcalf, 1979} {Vinay Krishin Gidwani, 1992} The most cited among the reasons for the pauperisation of rural masses was the introduction of land-tenure systems as a means of raising revenue for the East India Company by way of extracting taxes from those who cultivated land. The three main classes of land-tenure systems introduced by the colonial government, beginning with the Permanent Settlement of 1793 in Bengal Presidency, were: (i) a landlord-based system (also known as *zamindari* or *malguzari*) in Bengal, (b) an individual cultivator-based system (*raiyatwari*) in Bombay and Madras, and (c) a village-based system (*mahalwari*) in North-Western Provinces. The land reforms were carried out with the prime objective of maximising land revenue to the imperial government; the land taxes were 90 per cent of the rentals to begin with and were mostly settled at 50 per cent of the rentals all over India.{Romesh Dutt, 1908}[46] The primacy of land tax as the major source of revenue of the colonial government could be assessed from the fact that in 1841 it constituted 60 per cent of total British government revenue. {Abhijit Banerjee and Lakshmi Iyer, 2005} Worse, a third of the revenue generated from India was remitted out of the country.[47] The agrarian policy of the British raj induced land alienation, indebtedness to moneylenders, draining away of the purchasing power of the people, and contributing to millions of Indians dying in repeated famines in the nineteenth and early twentieth centuries. Investment

45 Ian J. Kerr (1995) provides this information. 'Unusual exertions', using Berkley's phrase, were needed to obtain the requisite labour. One of Berkley's assistants tells us what these exertions involved in the case of the Bhore Ghat, part of the Great Indian Peninsular Railway: "There is no local labour and therefore the difficulty of collecting and organising the workmen had to be commenced almost afresh after each rainy season. This was effected by sending numbers of maistrys and muccadums corresponding to foremen and gangers to the different towns and villages in a circuit of 200 or 300 miles supplied with money to enable them to advance small sums merely sufficient to keep the men on the road. The labourers thus collected were taken to the nearest railway station on the Concan or Deccan where their fares were paid for them to Khandalla or Campoolee at the top or the foot of the Ghat as the case might be." Quoted from Graham, ICE MS No. 1161) pp. 120

46 Romesh Dutt (1908) observes: "In northern India they fixed their demand of rent at 83 per cent of the rental, then at 75 per cent, then at 66 per cent. But even this was found to be impracticable, and at last, in 1855, they limited the state demand to 50 per cent of the rental. And this rule of limiting the land revenue to one-half of the rental was extended to Southern India in 1864. An income tax of 50 per cent on the profits of cultivation is a heavier assessment than is known in any other country under a civilised government." pp. x Preface.

47 Romesh Dutt (1908) observes, "The total land revenue of Indian was 17½ millions in 1900–1. The total Home Charges in the same year came to 17 millions. It will be seen, therefore, that an amount equivalent to all that is raised from the soil, in all the Provinces of India, is actually remitted out of the country as Home Charges." pp. xv Preface

in irrigation projects aimed at export-oriented cash crops through intensive agriculture and railway constructions caused large-scale ecological disasters in fertile areas, resulting in reduced price for agricultural products, swamping of land, malarial epidemics, and lowering of standard of living of the agriculture-dependent rural people. {Elizabeth Whitcombe, 1972, 1986, 1993} Gyan Prakash (1999) has studied how increasing commercialisation of agriculture during the nineteenth-century Bihar objectified relations in land; the *kamia*s were 'subjected' to a variety of practices that relegated them to the status of debt-serfs. Indebtedness increased among all classes of farmers. Imperialist policy-resultant impoverishment was not limited to agrarian population. The industrial and trade policy of the imperial government decimated India's textile and craft-based industries, making the country a source of raw material for British factories and a market for the finished goods, and throwing millions into unemployment. {A. Rahman, 1981} Tariffs were manipulated to facilitate import of finished goods from Britain, decimating Indian industries. {Romesh Dutt, 1908} All these policies ensured that large masses of impoverished people were available to take up any job in any condition.

A direct reference to how brick-kiln workers were sourced from Pratapgarh district of Uttar Pradesh at the beginning of the twentieth century is given by Jan Lucassen (2008). Hardly anyone of the ordinary rural population owned land, but all rented it. Most tenant families worked less than two acres. Pratapgarh, incidentally, had been depicted as a prosperous district. He quotes, "...One fact that tends to prove the general prosperity of the tenants is that, in spite of their hand-to-mouth existence and their utter disregard for sexual restraint, they can always pay their rents, even in bad years. ...All the tenants of the inferior castes readily avail themselves of opportunities of increasing their resources by work other than agriculture; they will go for long distances for employment on roads, railways and other works, leaving their women and children at home. The higher castes are restrained by their pride from such pursuits, but large numbers of brahmins and Rajputs still find employment in the army and police, many of them going far afield. All this distant work helps to swell the resources of the people, although it is not possible to say to what extent they are assisted by cash remittances from outside."[48] Such seasonal work paid more than the local agricultural work, which was paid in kind. For ploughing and manuring they received on an average a daily wage of 1½ *ser*s of grain and irrigating with the well two *sers*. The average monthly cash wage for an able-bodied agricultural worker was three rupees according to the returns from 1873 to 1900.[49] Landlessness, non-remunerative agriculture, its seasonality and low wages created a huge chunk of population, especially from the lower castes, readily available for work in the brick kilns.

To recapitulate the discussion so far, (i) the technology of brick production (moulding of bricks and firing of bricks) was known to India since Harappan and Indus Valley civilisations; (ii) during the post-Harappan period, stretching through the Mughal era, the use of brick as a building material came down significantly, except in eastern parts of India; (iii) nevertheless, the technology of burnt-brick production was preserved and practised by a certain community in Indian caste hierarchy and that was put into service in villages as small-scale activities; (iv) the situation changed with the arrival of the British imperialists, who engaged in large-scale construction activities like railways, irrigation, garrisons, bungalows, etc., which required huge volumes of bricks; (v) the British imperialists, who were not interested in strengthening Indian manufacturing capabilities, without altering the moulding and firing technologies, scaled up the production of bricks – transforming brick-kiln production from artisanal production to a rationalised industrial mass production; (vi) this involved introduction of significant innovations in the sourcing of labour, in the deployment of labour and in the organisation of production, which were in effect the origination of those elements that characterise the Indian brick-kiln sector like sourcing of labour through contractors by paying advances, workers working against debt in the kilns, piece-rate wages, contractors controlling work and payment of wages, strict division of tasks and deployment of labour along caste lines in these tasks, etc.; (vii) on the other side, the imperialist taxation policies, agrarian reforms, trade and industrial policies, and repatriation of revenue and other fiscal policies created a condition whereby the impoverished rural and urban people were available to be cajoled into work in industrial brick kilns.

The discussion so far begs an important question. From where has the elements of innovation – sourcing of workers and organisation of production – come in? This needs

48 Jan Lucassen (2008) pp. 555–556. Quoted from Neville, Pratapgarh: A gazetteer, pp. 49–50

49 ibid. pp. 556

further exploration. Was it imported from Britain or Europe? What was the condition of brick production in the UK and other European countries at that time? Were the innovations in brick production imported from the imperial centres to the colony?

Bricks in 18th and 19th Century Britain

In an interesting article, Jan Lucassen (2008) compares brick industry and labour organisation in Europe around 1700–1900, largely in the rural parts, with similar regions of India from about 1800–2000. The study presumes that manual brick production was a rural industry with rather a low degree of mechanisation, both in Europe and in India, and that the European societies were as hierarchical and inegalitarian as in India. Two major similar characteristics of the brick kilns during the period compared, as identified by the author, are seasonality of brickmaking having 'important consequence for the organisation of work process' and the migratory labour. Justifying the selection of the period of comparison – Europe up to 1900 versus India up to 2000 – the author says that since the end of nineteenth century several inventions gradually diminished seasonality of brick manufacturing: kilns were introduced for continuous firing, devices for the artificial drying of bricks, and moulding machines. As a result, brickmaking became an ordinary year-round production process involving – because of an upsurge in productivity – the employment of many fewer workers no longer migratory, but living near the factory. He says, with a few exceptions, "a century after Europe and the US, India with its five million brickmakers has yet to evolve to that stage." {Jan Lucassen 2008} pp. 518

In Europe, city enlargement and public works like the construction of barracks, prisons, roads, canals and railways created such huge demand for bricks. The Great Fire of London in 1666 provided a real impetus to the brick industry as Parliament passed laws banning the building of timber buildings and this created a demand for bricks. The canal building era of the eighteenth century and the railways in the nineteenth century demanded high-quality bricks and it was during this period that many innovations were introduced to brickmaking. During the 1840s, between 25 per cent and 39 per cent of the total brick production went into building the railways. {Jonathan Dicks, 2015} Jan Lucassen describes that the industrial mode of production of bricks was carried out in clamp kilns, where green bricks were mixed with fuel and the stack was enclosed by bricks that had already been burnt. After firing, the whole clamp was dismantled; there was no independent kiln structure. The production capacity of the clamp varied from only a few tens of thousands to 300,000, and several clamps were fired at the same time on one field, where even thousands of workers might be needed. Such a sudden huge demand for semi-skilled workers was met by employing migratory labourers specialising in this type of work and not by those who were available locally. The migrant labourers were both willing and able to leave other occupations during the brick season and they were likely to be smallholders or crofters (those having rented farms), who were able seasonally to leave their land in the care of other family members. (Jan Lucassen 2008) pp. 520

Jan Lucassen then goes on to give empirical evidences from eighteenth-century Italy and Holland and nineteenth-century England. In Italy, landowners would have been the most likely individuals to invest in such industrial establishments, which they then rented out to artisans. The workforce, although not engaged all year and so unemployed, would have been local. From the Florentine evidence, the work seems to have been highly specialised. *All tasks from the digging of clay to the tempering up and moulding were done by the moulder and his family, who were paid by thousand of green bricks. The next stage of the work was the job of the kilnmen, organised into guild, who might, if it were necessary, hire supplementary hands to transport both the green and fired bricks. Finally, the carting of the fired bricks to the building site was done by men who were in turn organised as a separate section of guild.* (Jan Lucassen 2008) pp. 525–527

In the seventeenth- and eighteenth-century Holland, something similar occurred to what happened in Italy: but now the workers become rather more visible. In Holland too, brickmaking was a rural industry but was sited alongside waterways near urban centres. *Local family was the rule.* Along the Oude Rijn, work was also seasonally bound, but, for some workers at least, alternatives were available during the off-season in the digging of clay and transporting it to the kiln. (Jan Lucassen 2008) pp. 527

England is the third country for which Jan Lucassen gives information about, especially for about the first half of the nineteenth century. At that time, three production areas dominated the brick industry: Staffordshire (along with adjacent Derbyshire and Leicestershire), Nottingham and Southern Lancashire, and the area around London. Just as in Woerden in the nineteenth-century Holland and those

other important Dutch riverside production centres Utrecht and Gelderland, in certain areas in England *family labour (including child labour) seems to have been normal, though not everywhere*. (Jan Lucassen 2008) pp. 529

It is rather surprising why Jan Lucassen chose 20th-century India and not nineteenth-century India while comparing it with brick production in England and other European countries. It is a different matter why India remained at a low level of mechanisation in the twentieth century. It could be seen that the industrial brick production that happened in India had many similarities with what was witnessed in Great Britain and Europe during the same period, particularly in ways in which organisation of production was managed.

Jan Lucassen exhibits Euro-centrism in his approach, from comparing brick-manufacturing processes at different times, though processes could have been similar at the same point of time, and not examining the reasons for approximations to European mode of production of bricks in India from a traditional process of brickmaking by Kumhars (which he acknowledges).

In the 19th century, Britain's brick-kiln production was dominated by small-scale manufacturing units, mostly clamp kilns. These units were limited in scale by the size of the market available within a day's travel by horse and cart, and were, therefore, largely confined to parts of the country where suitable clay deposits coincided with centres of population. {S.W. Davies, 1971} {Kathleen Ann Watt, 1990}. Kathleen Ann Watt identifies the following job divisions in a kiln: (i) *moulders*, traditionally considered the most skilled workers in the brickfield because hand moulding required accuracy, speed and a great deal of strength to keep up the necessary movements for a 10- to 13-hour day; (ii) *temperer*, who supervised the preparation of the clay, needed both knowledge and judgement to bring the paste to the optimum consistency; (iii) *pug boy*, the pusher out and the barrow loader (usually children); (iv) *soiler* regulated the addition of ashes to the clay mixture; (v) *walk-flatter* (also known as wall-flatter or wheeler), the person who brought the clay in brick-sized lumps from the pug mill to the moulding table; (vi) person who *burns the bricks*; (vii) *off-bearer*, who removed the moulded bricks from the moulding table. The hand-brickmaking process, therefore, relied technically on an interdependence of skills rather than on the inherent superiority of the moulder's abilities. These job divisions resembled job divisions that the imperial government had introduced in the brick kilns of India.

There are uncanny resemblances in the sourcing of labour and organisation of work – especially subcontracted *gang* work, *child labour* and *piece-rate* work – in the kilns too. Kathleen Ann Watt gives this information: "The importance of the moulder in the brickmaking operations was founded principally upon his socially central position as *gang* leader. The subcontract system established a set of relationships based on work control and craft consciousness that were firmly entrenched within the industry. The moulders were engaged by the master brickmakers for a price per thousand bricks and then they chose the other members of their work groups. Thus they controlled access to all other jobs in the gang and the opportunity for others to acquire brickmaking skills. With this power, they maintained the exclusiveness of their own positions and the strict hierarchy of the jobs beneath them. This is reflected in the distribution of wages paid to the gang members. For example, in 1866 a total payment of 4s.4d. to the gang leader was distributed as follows: 7d. together to the pug boy, the pusher-out and the barrow loader (usually children), 4d. to the walk flatter, ls, each to the temperer and off-bearer (who removed the moulded bricks from the moulding table), and ls.5d. to the moulder (*BPP Children's Employment Commission 1866, p. 138 and 140*). The moulders also controlled the pace of the work and the number of hours worked each day by the entire gang. One brick-master stated: 'The hours for day workers are from 6 am to 6 pm, but the moulder is paid by the thousand... so they please themselves. I have often known them to work from 4 am to 9 pm at the height of summer, so long indeed as the moulder can see to put a brick into the mould.' (*BPP Children's Employment Commission 1866, p. 137; BPP Factory and Workshops Act 1876, p. 366*)." {Kathleen Ann Watt, 1990} pp. 39–40

Equally noteworthy was the rationalisation of work, maximising productivity by minutely assessing every action of the workers and controlling it by the design of space, placement of equipments, allocation of people, etc., {Edward Dobson, 1882} much before Henry Ford's work organisation based on time and motion studies. In 'A rudimentary treatise on the manufacture of bricks and tiles: Containing an outline of the principles of brick-making', Edward Dobson (1882) describes the successive operations of brickmaking as practised at works in London. "The brick-earth is turned over to receive the malm as near as possible, to the clay pits. The clay and chalk mills are placed close together in some convenient position, so as to interfere with the works as little as can be helped, and the malm is conveyed from them to the heap of brick-earth, by means of troughs or shoots supported on tressels. Close to

the brick-earth, and immediately behind the moulding stool is placed the pug-mill, and in front of the moulding stool is the hack ground, which should, if possible, be laid out with a gentle fall towards the clamps, which is placed at its furthest extremity. These arrangements are of course much modified by the circumstances of the locality."[50] Besides ensuring arrangement of equipments in the most logical manner, each stage in the production has been rationalised maximising human resources and reducing wastage of time and materials. To illustrate, he describes tempering and moulding for stock bricks in London:

> "Before commencing moulding, the moulding-stool is provided with two heaps of dry sand, a tub of water, in which to place the strike, a stockboard and brick-mould, and three sets of pallets. Everything being in readiness, and a supply of tempered clay having been placed on the stool by the feeder, whose business it is to carry the tempered clay from the pug-mill to the moulding-stool, the clot-moulder, who is generally a woman, sprinkles the stool with dry sand, and taking a clod or clot, from the heap of tempered clay, dextrously kneads and moulds it roughly into the shape of a brick, and passes it to the moulder on her left hand. The moulder, having sprinkled sand on the stock-board, and dashed the mould into the sand-heap on his left hand, places the mould on the stock-board, and dashes the clot into it with force, pressing it with his fingers, so as to force the clay into the angles of the mould. He then, with the strike, which has been well wetted in the water-tub, removes the superfluous clay, which he throws back to the clot-moulder to be remoulded. The mould is then lifted off the stock-board, and placed by the moulder against one of the pallets, which he catches dextrously with his fingers, and, turning out the raw brick upon it, slides it along the page to the taking-off boy, and, lifting up the empty mould, dashes it into the sand, and replaces it on the stock-board, preparatory to moulding a second brick; when he has moulded one set of bricks; he scrapes away the sand which has adhered to the mould during the operation with the strike, and then proceeds with the next set. A moulder and clot-moulder, with the assistance of a feeder, a taking-off boy, and two men to wheel and hack the bricks, will make about 5,000 bricks between 6 am and 6 pm; but this quantity is often exceeded."[51]

The rationalisation of production processes including deployment of labour is despite not so elaborate requirements of equipments and materials required for brick-kiln manufacture in the nineteenth-century Great Britain. Edward Dobson lists for London stock-brick production the following items: (i) chalk and clay mills, (ii) pug-mill, (iii) cuckold, (iv) moulding stool, (v) 1 mould, (vi) 3 sets of pallets, (vii) 3 bearing-off barrows, (viii) in addition to the above, a few planks, shovels, barrows, buckets, sieves, and other articles... "no buildings are required for the actual manufacture. It is, however, usual for the foreman, or moulder, to live at the field,"[52] he adds.

Bricks, once moulded and dried, were burnt in *clamps* or in *kilns*. In the *clamp* burning, each brick contained in itself the fuel necessary for its vitrification. Bricks were closely stacked and once the fire was ignited in the lower tiers of bricks, the heat gradually spread over the whole of the clamp. In contrast, a *kiln* was a chamber in which the green bricks were loosely stacked, with spaces between them for the passage of the heat, and baked by fires placed either in arched furnaces under the floor of the kiln, or in fire holes formed in the side walls.[53] The kilns, up to the 1850s, did not have chimneys. The clamp kilns in London were capable of producing 60,000 to 120,000 bricks, and elsewhere in the country, up to 250,000 bricks in a single clamp. {Alan Cox, 1997} These manufacturing units were capable of meeting the increasing demands for bricks for housing and railway-line construction. During the period, production of bricks increased from under 1,000 million up to over 3,000 million bricks a year. {S.W. Davies, 1971} The number of brickmakers, too, increased during the period, from 9,423 in 1831 to 45,087 in 1911. {Robin Lucas, 1997}

The following picture emerges: *one*, in Europe and Britain, brick kilns were usually small units nearer to the locations where demands existed, but capable of clustered operation in clamp or kiln to meet larger demands; *two*, brickmaking work

50 Dobson pp. 123

51 ibid. pp. 142

52 ibid. pp. 161

53 ibid. pp. 38-39

was a subcontracted exercise; *three*, workers, mostly migrants, worked in gangs and the gang leader not only sourced workers but also controlled work at site and decided on distribution of wages; *four*, family labour – men, women and children – worked as brickmakers; *five*, working hours were long, more than 12 hours a day; and *six*, the activity of making of bricks was fragmented into various sequential steps and assigned to different groups of workers to rationalise production and improve productivity.

Doesn't this sound familiar? Imperialist British contractors and engineers were importing the production techniques and organisation to India, to meet the increasing demands for bricks in the country. However, as we have already seen, its application was not straightforward. The fiscal, agrarian and industrial strategies of the imperial British in India made available impoverished people in large numbers to work in the kilns and they were cajoled into work in the kilns in a work culture alien to the traditional brickmakers in India. The mobilisation strategies and deployment of labour in the kilns were carefully manoeuvred, accommodating the social and caste prejudices existing in India, and not disturbing them.

Not only the application of technology was distorted, but its import was also selective.

Technological Innovations in Brickmaking in Britain

Jan Lucassen is right in saying that in the US, the UK and in Europe, brick-kiln manufacturing is no more the same after incorporation of various technological and organisational changes wherein kilns produce year-round and workers are no more migratory and that India in the twenty-first century is yet to evolve to that stage. This takes us to the question whether the British had in fact transferred technologies that had the potential to free workers from most tedious, 'dirty', exploitative work and would have made Indian brick production round the year? Available information indicates that there had only been selective transfer of brick-kiln technology by the imperial British to India.

In the UK, from 1830 onwards a number of improvements were introduced in the methods of clay preparation and the moulding of bricks, in addition to the presence of clay mills and pug-mills to prepare clay. Dobson divides brick machinery into 'two great classes, wet and dry clay machines, i.e., machines which form the brick, by moderate pressure in moulds, from already tempered and plastic clay, and those which, under a far more severe compression, mould the bricks from clay perfectly comminuted, but either dry, or at most only very slightly moistened.'[54] However, the pace of inventions was relatively slow till 1850, till the tax on bricks, which acted as a disincentive, was withdrawn by the government.[55] Following repeal of the excise duties on bricks in 1850 and the passage of the 1852 Patents Act, a substantial increase in the number of patents granted for brickmaking machinery was recorded. A large number of patent applications were filed in brick-clay extraction and moulding. Between 1851 and 1873, approximately 364 patents were enrolled for machines capable of shaping bricks and tiles.[56] (Kathleen Ann Watt, 1990) Dobson gives the list of 14 patents registered in 1861 and 1862 pertaining to inventions in making bricks.[57] The wire-cut process of shaping the clay was designed and perfected by 1860, followed by the semi-dry process. {S.W. Davies, 1971} There were also innovations, during the second half of the nineteenth century, in the burning of the bricks moving from periodic kilns to continuous kilns. 'The greatest improvement that has ever been made in the construction of kilns, of at once drying and burning bricks'[58] was the ring oven

54 Edward Dobson pp. 211

55 The British Parliament in August 1784 proposed the tax on bricks and tiles, and was, with modifications and clarifications, remained in force until repealed in March 1850.

56 Kathleen Ann Watt, pp. 158

57 Dobson says, "We may, however, in order to show the great vitality of the trade, quote a few titles of inventions, &c., belonging to the years 1861 and 1862. The patent list displays the strong tendency to invention for making bricks, by machinery. Thus, we have Wimball's patent for making bricks, tiles, and drain pipes; Morrell and Chamley's apparatus for making bricks, tiles, and other articles from plastic materials; Green and Wright's machinery for the manufacture of plain and ornamental bricks, slabs, tiles, and quarries; Basford's patent for constructing brick walls, and ornamenting the materials to be used for the same; Effertz' machinery for making bricks, tiles, &c.; Grimshaw's patent for compressing brick-earth and other materials; Morris and Radford's patent for the manufacture of fire bricks, blocks, &c.; Pooler's patent for making ornamental bricks, tiles, &c.; Newton's machine for making bricks; Sharp and Balmer's apparatus for the manufacture and drying of bricks; Grimshaw's patent apparatus, used in drying, pulverising, and compressing clay; Platt and Richardson's apparatus for making bricks; Foster's method of rendering bricks impervious to damp; Smith's apparatus for the manufacture of bricks, tiles, &c." pp. 195–196

58 Edward Dobson, pp. 237

patented in Germany by Frederick Hoffman in 1858, which was patented in Great Britain by H. Chamberlain. The original Hoffman's kiln was a circular channel, where the bricks were kept, the fuel fed in by apertures in the top of the arch, and the fire movement caused by the draught of a large chimney placed at the centre.[59] 'Tunnel kiln', a reversal of the principle of Hoffman's kiln in which the bricks to be fired are placed on carts and passed through a long horizontal tunnel while the fire situated at the centre, was patented in Germany in 1877 by Otto Bock.[60]

Britain's brick industries became more mechanised by 1900, though the new methods of firing were adopted only very gradually. Technical improvements and mechanisations were largely confined to pre-firing processes, including the artificial drying of raw bricks, the winning and moving of clay. Between 1930 and 1939, output rose by 54 per cent over the same period, with a peak of over 6,500 million bricks in 1938, though employment rose by only 7 per cent and the number of establishments by about 10 per cent; after war, it reached a peak output of 7,500 million bricks in consonance with the growth in the demand for bricks for house construction. {S.W. Davies, 1971} A recent British Geological Survey commissioned report (2001) corroborates the observation by Davies that the UK's brick establishments are increasingly adopting tunnel kiln technology. The report says that brick production, which declined since 1974, has stabilised at around 3,000 million tonnes a year and that the number of companies and works producing bricks has declined by about two thirds since 1979, which has to do with the decline in house construction and availability of alternative construction materials.[61] {A.J. Bloodworth et al., 2001}

In the 19th-century Britain and in other countries of Europe, technological innovations were taking place at a frantic pace in the preparation of clay, moulding and burning of bricks. But the British civil servants and technologists, despite being on a 'civilising mission' in India, were not interested in importing those technologies and applying them in brick manufacturing here because they already had imported and adapted organisational and labour exploitation principles to extract labour power from the abundant labour in the country, with the exception of one or two hesitant steps. In 1848, the British Military Board imported Hall's[62] horse-drawn and bullock-drawn brickmaking machines to be used in the units attached to Ganges Canal work, reportedly to reduce costs by introducing labour-saving machines and cheaper labour contracts. These experiments do not seem to have received wide acceptance by the contractors engaged by the imperial power. Interestingly, the contractors attributed their reluctance to adopt technology in brickmaking in India to the resistance offered by workers. 'Workers repeatedly damaged the machine, making it inoperable.' {Jan Lucassen, 2008} pp. 549

The Bull's Trench Kiln – The Imperialist Invention in India

The imperial establishment continued to experiment with brickmaking processes that would reduce the power of workers and increase the efficiency of the kiln without compromising on the deployment of available abundant cheap labour. The result was the bull's trench kiln. The inventor was William Bull, an English engineer. However, as generally presumed in the writings on the brick industry in India, the technology was not imported from the UK. The location of the unit was Calcutta. Jan Lucassen writes, "In various stages between 1872 and 1896 and in close cooperation with two of his brothers, of whom one was in the Indian army and the other a private contractor in Bengal, William Bull developed the bull's trench kiln." It was an invention in India, for India, by the British as in the case of Captain Bertie-Clay of the Indian ammunition works

59 The Hoffman's kiln is acknowledged to have revolutionised the brick and tile production industry. It allowed for a better and more uniform quality of ceramic goods; it was economical in terms of fuel consumption and labour costs; and it raised the production output spectacularly – up to 10 million bricks per factory per year.

60 Ritchie, T. (1980) in 'A History of the Tunnel Kiln and Other Kilns for Burning Bricks' writes, "Practical application of the principle of the tunnel kiln ... may first have been made in France in 1854, when Colas tunnel was used to burn bricks and tiles. Other tunnel kilns were constructed before 1878 by Otto Bock in Germany, by John Foster in England, and by M. Curot in France. ...One of the first tunnel kilns in England was patented in 1869 by William Cliff." pp. 51

61 The UK brick industry is now dominated by six companies that account for almost 90 per cent of brick production. Between 25 and 30 small manufacturers account for the remaining brick production in mainland Britain. None of these smaller manufacturers produced more than 50 million bricks in 1998. Of the 8.2 million tonnes of clay consumed by the industry in 1998, almost 95 per cent was used in the manufacture of bricks. pp. 8

62 Alfred Hall of the United States invented the machine in 1845. {Kathleen Ann Watt, 1990, #10097} pp. 166

at Dum Dum who patented the mushrooming, or in 1897, a vicious invention that 'tore great holes in the flesh', perfecting the art of war.[63] The result of using the 'dum-dum' bullet was so gruesome that the imperial military used it only against the 'natives'. William Bull perfected the art of brickmaking in India in the late 19th century and deployed it in South Asia – in Pakistan, India, Bangladesh and Myanmar, the British colony. The bull's trench kiln had its advantages over the then existing clustered clamp kilns. It had movable metal chimneys placed on the brick setting and were moved as the ring progressed. A semi-continuous firing kiln, it preserved heat and could be continuously loaded and unloaded during the season. Evidences suggest that the imperial government promoted the use of the bull's trench kiln in their various construction activities. Statement showing the expenditure incurred in the Irrigation Branch, North-Western Provinces and Oudh, for the official year 1882–83 of the imperial government has an entry, 'Mr. Bull's patents for brick burning', allocating Rs 10,000 in 1882–83 from the government's exchequer. (Table 1) In the same year, an abstract indicating the position of the principal factories in the North-Western Province and Oudh shows that the imperial government maintained 10 brickmaking factories, each employing 132 workers. (Table 2)

Compared to the existing kilns in colonial India, the bull's trench kiln was an adaptation of experiments in continuous firing technology being developed in Europe, but it was a poor adaptation. Hoffman's kiln, for example, could be in operation continuously all through the year, as the structure had a roof, which allowed operation in all weathers. This simple step has made brick and tile manufacturing a regular job for brickmakers, improving their employment status and income. Bull's adaptation of the continuous technology essentially kept it a periodic kiln, discontinuing production after the season. Moreover, the bull's colonial adaptation of continuous firing technology allowed for the dismantling of kilns after the kilns finished serving the purpose of providing bricks to location-specific irrigation canal and railway construction activities of the British. Hoffman's kilns were permanent structures with thick walls and roof, which couldn't be dismantled without incurring heavy losses unlike the bull's adaptation, which replaced the roof by a cover of bricks and sand and the permanent chimney with movable chimneys. Bull's trench could have been quite advantageous to the British engineers and contractors. It was more fuel-efficient compared to the periodic kilns that were being used; required low initial investment compared to Hoffman's kiln; and assured greater volumes of bricks from the high-capacity kilns. Bull's adaptation did not alter, in any way, the clay preparation and moulding processes, which remained manual and labour-intensive as earlier. Consequently, the bull's trench kiln did not alter the labour sourcing, labour deployment or organising principles of the brick kiln, which could have in any way contributed to the empowerment of workers. Rather, it did contribute in knocking down the organising potentials or possibilities of workers by further disintegrating and 'rationalising' work in the kiln. Bull's trench kiln 'split up the originally large firing gangs into less skilled loaders and unloaders and more skilled, but far less in numbers, fire-men.'[64] Reading this development, the one of categorising firing as the skilled work compared to other work roles in the brick site, with the previously discussed caste-based gangs at work, would get a context where a caste-based allocation of work in brick kilns is established and justified. Those who are working on mud are the menials; those associated with work with a semblance of trade, higher in the hierarchy; and those working on fire the highest. A brahminical, casteist allocation of work crept into the brick-kiln sector. We get a deadly mixture, when those doing clay preparation and moulding jobs in the kilns are sourced through payments of advances, against the repayments of which they had to work in the kilns under gang leaders. Worse still is the total disregard for the health of workers – men, women and children – who are exposed to dust, smoke, heat and polluting emissions. Bull's trench kiln has been a technology because the Indians were expendables and were available in distress, in large numbers, to work in the kilns.

However, it needs explanation as to how and why the bull's trench kiln became so widespread, especially in the Indo-Gangetic plains from Afghanistan to Bangladesh. For this, let us go back to the discussion by Daniel P. Headrick on

63 Daniel R. Headrick (1979) discusses the history of the development of the technology of fire arms arguing that the history of imperialism is intertwined with the developments in the art of war. He says, "Technology of firearms progressed from the muzzle-loading smoothbore musket with a bayonet; to rifles; to the introduction of percussion cap; to the development of cylindro-conoidal bullet; to the replacement of Brown Bess with the Enfield by the British; to the replacement of paper cartridge by a brass cartridge that held the bullet, powder and cap together; to the introduction of Snider-Enfield; to the invention of smokeless explosives; to the development of Cordite; to the invention of the magazine and the repeating mechanism; to the development of machine gun." pp. 256

64 Jan Lucassen, 2008, pp. 554

Table 2: **Statement Showing the Expenditure Incurred in the Irrigation Branch, North-Western Provinces and Oudh, for the Official Year 1882–83**

III. PRODUCTION AND DISTRIBUTION						
D. IRRIGATION						
II. Statement showing the expenditure incurred in the Irrigation Branch, North-Western Provinces and Oudh, for the official year 1882–83						
Details	Total of each canal			Total of each class		
	Original works	Repairs	Total	Original works	Repairs	Total
A. – IMPERIAL	Rs	Rs	Rs	Rs	Rs	Rs
I – Famine Relief and Insurance						
Betwa Canal	660,531	...	660,531	...	...	...
Total	660,531	...	660,531	660,531	...	660,531
Establishment	...	...	...	...	...	147,165
Tools and plant	...	...	...	...	...	45,356
Increase in suspense balances	...	...	...	...	...	26,425
Less receipts on capital account	...	...	...	...	...	-1,963
Total, famine relief and insurance	...	...	...	...	...	877,514
II – Agricultural Works						
Ganges Canal	...	4,858	4,858	...	...	...
Mr Bull's patents for brick burning	10,000	...	10,000	...	...	...
Total	10,000	4,858	14,858	10,000	4,858	14,858
Establishment	...	...	...	...	...	1,117
Total, agricultural works	...	...	...	...	...	15,975
III – Productive Public Works – Capital Accounts						
Ganges Canal	235,955	...	235,955	...	...	...
Lower Ganges Canal	760,088	...	760,088	...	...	...
Agra Canal	50,742	...	50,742	...	...	...
Eastern Jumna Canal	39,258	...	39,258	...	...	...
Total	1,086,043	...	1,086,043	1,086,043	...	1,086,043
Establishment	...	...	...	...	...	249,790
Tools and plant	...	...	...	...	...	-9,425
Decrease in suspense balances	...	...	...	...	...	-58,786
Less receipts on capital account	...	...	...	...	...	-555
Total, productive public works – capital account	...	...	...	...	...	1,267,067
Total, imperial	...	...	...	...	...	**2,160,555**
B. – PROVINCIAL						
I – Productive Public Works, Revenue Account						
Ganges Canal	115,762	299,581	415,843	...	...	...
Lower Ganges Canal	34,137	254,905	289,612	...	...	...

Agra Canal	25,804	88,572	114,376	...	...	...
Eastern Jumna Canal	18,470	78,087	96,557	...	...	...
Total	194,173	721,145	**916,388**	194,773	721,145	915,918
Establishment	...	...	...	...	...	928,402
Tools and plant	...	...	...	...	...	26,324
Revenue refunded	...	...	...	...	...	3,424
Total, productive public works, revenue account	...	...	...	...	...	**1,874,068**
II. – Works Not Classed on Productive Public Work, Capital Account						
Dun Canals	...	...	...	...	...	...
Rohilkhand Canals	16,442	...	16,412	...	...	...
Bundelkhand Irrigation Survey	228	...	228	...	...	...
Sardsa Canal Survey	1,256	...	1,258	...	...	...
Cawnpore Branch Extension Survey, Lower Ganges Canal	3,659	...	5,639	...	...	...
Total	21,585	...	21,585	21,585	...	21,585
Establishment	...	...	...	...	...	10,984
Tools and plant	...	...	...	...	...	3,639
Increase in suspense balances	...	...	...	...	...	3,422
Total, works not classed as productive, capital account	...	...	...	...	...	**39,630**

Source: Report on the Administration of the North-West Province and Oudh, for the year ending 31st March 1883, Allahabad: North-Western Province and Oudh, Government Press. pp. 75

Table 3: **Abstract Indicating the Position of the Principal Factories in the North-Western Province and Oudh during the Year 1882–83**

Abstract indicating the position of the principal factories in the North-Western Province and Oudh during the year 1882–83

II Factories Maintained by Government

Description	District	Name	Nominal horse-power of engine	Average number of persons employed daily	Value of raw materials worked up (Rs)	Value of manufactured outturn (Rs)	Cost of factory to government (Rs)
Harness Factor	Cawnpore	Government harness factory	24	900	500,000	150,000	
Engineering Workshops	Aligarh	Post-office factory		896	142,846	261,499	32,766
	Roorkee	Canal foundry	47	859	418,000	705,000	
Jail Industries			No. of jails in which industry is pursued				

Class I		Aloe fibre making	7	56	89	965	
		Munj twine making	25	593	6,035	14,017	
		Rope making	14	125	1,063	2,709	
		Gunny-making	24	350	6,393	15,619	
		Net-making	3	6	94	226	
		Total	73	1,940	13,674	33,536	
Class II		Basket making	2	2	24	30	
		Cane work	3	12	279	484	
		Total	5	14	303	514	
Jail Industries Concluded							
Class III		Cloth weaving	47	715	42,064	60,475	
		Cotton factory	5	10	1,775	2,405	
		Tent making	1	16	6,136	8,182	
		Drugget (duri) making	45	584	21,650	40,391	
		Wood working	1	106	23,425	26,793	
		Spinning	8	127	10,043	12,036	
		Carpet (rug) making	40	951	41,500	1,08,617	
		Blanket making	46	456	24,019	30,823	
		Stocking-knitting	1	3	18	41	
		Tilory	9	44	11,336	13,954	
		Shuttlecock making	1	1	15	74	
		Total	104	3,070	205,681	305,800	
Class IV		Skin curing	1	4	177	441	
		Shoe making	7	13	1,477	1,974	
		Total	8	17	1,654	2,615	
Class V		Carpenter's shop	11	36	603	1,970	
		Blacksmith's shop	13	52	1,739	3,574	
		Goldsmith's shop	1	.1		2	
		Tin factory	2	4	258	488	
		Stool making	1	2	117	217	
		Total	23	94.1	2,717	6,247	
Class VI		Paper making	7	53	991	1,667	
Class VII		Lithography	4	22	883	1,311	

		Printing	2	36	6,637	18,804	
		Total	6	58	7,520	20,115	
Class VIII		Dyeing	13	51	12,564	17,760	
Class IX		Oil Pressing	28	42	5,812	8,918	
Class X		Lime grinding	2	7	712	1,025	
		Brick making	**10**	**132**	**7,706**	**16,312**	
		Pottery	13	142	3,767	8,961	
		Total	25	281	12,245	26,298	
Class XI		Bakery	5	47	9,805	12,153	
		Dairy	1	.03	75	139	
		Total	6	47.03	2,880	1,292	

Source: Table 11: Factories Maintained by Government, Production and Distribution, Report on the Administration of the North-West Province and Oudh, for the year ending 31st March 1883, Allahabad: North-Western Province and Oudh, Government Press. pp. 142–143

the diffusion of technologies. According to Headrick, as we have already discussed, technological transfer to the colonies did not lead to an inevitable process of industrialisation but rather to the destruction of even the existing industrial base. Secondly, the colonialists intentionally used technologies as tools of empire to conquer territories and establish political, economic and military control over the colonised. Third is the stage of diffusion, wherein the people who are colonised assimilates the technologies and became consumers of the technologies.[65]{Daniel R. Headrick, 1988, #5987} {Daniel R. Headrick, 2010} Indians, a new class of people traditionally not associated with brick production, entered the scene and accepted the bull's trench kiln technology in totality. They inherited not only the brickmaking and the brick-burning technology from the British, but also the methods of sourcing of labour and their casteist deployment of labour in the kilns.

Conclusion

The factors that we identified as organisational innovations towards mass production of bricks in India by the imperial British to meet the increased demand from public works in irrigation and railway lines were deceptive. The organisation of work which Ian J. Kerr qualified as 'ordered, rationalised, disciplined industrial activity' was actually importation and then the distorted implementation of putrified organisational principles of a form of industry in decline. The British imperialists while bringing in the technologies of agricultural development, irrigation and railways to India – which we already saw have been imperial despotism to safeguard their economic and military interests – also imported highly exploitative industrial organisation and labour management practices with the objective of maximisation of capital accumulation. Ian J. Kerr approached the work organisation in railways and brick kilns from the theoretical perspective of *formal subsumption* and *real subsumption* of labour, the Marxian perspective of how capitalism establishes itself. The advances, working in gangs under gangers, caste-based gangs, hierarchical fragmentation of tasks and piece-rate wages, etc., formed part of the formal subsumption strategy of British capital by drawing into itself the existing processes in a less capitalist Indian context. However, the reality is that, particularly in the brick-manufacturing sector, the capitalists never moved into a situation of *real subsumption* of labour because the imperial invention and application of technology were done without disturbing the underlying social structures and customs – an imperial deception.

65 Daniel R. Headrick (2010) argues that technology is a double-edged sword, which turns back at the colonisers when the technologies are assimilated and used by the colonised people. He writes: "I have used India as a case study, both because it was the most important of the European colonial possessions, and because it illustrates the unpredictable consequences of innovations in communication technologies. The modernisation program that Dalhousie had instituted in India was designed to make Britain's presence on the subcontinent profitable and permanent. Instead, it undermined British rule. Historians attribute the decolonisation of India to a concept called nationalism and a change in the culture of India that united people from different regions and of different ethnicities and languages into one nationality. But what made nationalism possible in such a vast and culturally diverse land was the new communications media: the postal system, the railroads, the telegraph, the printing press, and the telephone. The increasing ability of Indians to acquire and disseminate ideas and information, using the very media of communication that the British had introduced, did not make British rule permanent, but undermined it instead."

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Centre for Education and Communication
173-A, Khirki Village, Malviya Nagar, New Delhi - 110017
T: 91 11 29541841 / 29541858 F: 91 11 29542464
Website: www.cec-india.org