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Moveable factories: How to enable sustainable widespread manufacturing by local people in regions without manufacturing skills and infrastructure



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ABSTRACT

Moveable factories enable high performance manufacturing. They carry their own power generation and are built to cover rough terrain. Hence, they have potential to enable more widespread modern manufacturing. In this paper, findings are reported from a study addressing two research questions. First, what goods should be produced by local people in regions without manufacturing skills and infrastructure? Second, how can lack of manufacturing skills and infrastructure be overcome? The study comprised literature review, semi-structured interviews, and structured questionnaire. Research participants are from Horn of Africa and from West Africa. All the goods that research participants considered to have potential for profitable production can be made with types of moveable factories that are available. Lack of local skills can be overcome through application of task design using proven techniques. In addition, techniques for designing capable production processes are applicable to moveable production. Established techniques for optimizing mix of production facilities, locations, and routes are also applicable. The robust mobility of moveable factories, and application of proven techniques, reduces the need for manufacturing infrastructure. Moveable factories are relevant to literature and debate concerning re-shoring/on-shoring/right-shoring/best-shoring manufacturing, sustainable manufacturing, advanced manufacturing, and distributed manufacturing. The relevance of moveable factories to these topics is analysed in terms of Resource-Based Theory, Knowledge-Based View, and Transaction Cost Economics.

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1. Introduction

Without widespread modern manufacturing, countries can have a bi-polar distribution of income with few rich, many poor and little, if any, middle class. Traditional manufacturing of goods using rudimentary tools in subsistence economies is inefficient and cannot be scaled up. Hence, poverty is endemic [1]. Countries that base their economies on exporting their raw materials wealth rather than on widespread modern manufacturing do not

generate a large middle class. Hence, poverty remains endemic [2]. Countries that off-shore manufacturing suffer a shrinking middle class. Hence, poverty becomes endemic [3]. However, centralized industrial manufacturing still leads to massive toxic waste and ecological destruction. Hence, pollution becomes endemic [4]. In this paper, research is reported that investigated potential for moveable factories to enable sustainable widespread modern manufacturing: in particular, by local people in regions without manufacturing skills and infrastructures.

The term, moveable factories, encompasses three types of production facilities that are designed and built to be operated efficiently at more than one location. Firstly,

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individual mobile factories that are housed within a large van or are mounted on the back of a truck in a shipping container or similar. Individual mobile factories are suitable when there is one type of production needed at a location and when production location changes daily or weekly, for example, during the processing and packaging of agricultural harvests. Secondly, sets of mobile factories that can comprise several shipping container size factory units with complementary production capabilities, such as roof truss fabrication and door set assembly. These are suitable when production location changes monthly or yearly, for example, during the construction of a group of buildings. Thus, sets of moveable factories can be deployed as flexible manufacturing systems comprising specialist manufacturing cells that enable highly efficient production of particular components. Thirdly, modular factories that can comprise several pre-fabricated volumetric elements that are delivered by truck and are assembled to make one factory that is several times larger than a shipping container. These are suitable when production location can be fixed for up to several years and/or special internal environments are needed, for example, clean environments for production of goods containing microelectronics.

Only a few types of production that need special internal environments have to be wholly within a moveable factory. Such moveable factories may need to be longer and wider than the size of a shipping container. This is because of the need to have specially covered insulated floors, walls, and roofs; as well as enough internal working space for people. By contrast, many other types of moveable factory can have work carried out around them, as well as inside them. When production is better enabled by doing so, the sides of moveable factories can open out. Then, temporary external working floors and protective roof coverings can be used to expand the work space.

Moveable factories have been available for decades. They can cover rough terrain and carry their own power generation. Yet, their potential to bring about sustainable widespread modern manufacturing has gone largely unrecognized. This can be attributed to centralized industrial production having been the dominant paradigm in manufacturing since the Industrial Revolution. This has led to economic development being synonymous with centralized industrial development. Hence thus far, moveable factories have been used as an occasional production solution at locations where it is not viable to establish centralized industrial manufacturing. These locations include remote areas in rich countries where there is need for seasonal processing of forest berries and roaming livestock. In recent years, however, many very serious shortcomings of centralized industrial manufacturing have become apparent. These range from excessive non-value adding transportation to limited potential to provide location-specific/person-specific goods [5,6]. Awareness of such shortcomings calls into question whether economic development should continue to be synonymous with centralized industrial development.

The study addressed two research questions. First, what goods should be produced by local people in regions without manufacturing skills and infrastructure? Second, how can lack of manufacturing skills and infrastructure be

overcome? The study comprised literature review, semi-structured interviews, and structured questionnaire. Research participants are from Horn of Africa and from West Africa. They are from two diaspora associations. This is because diaspora members have up-to-date knowledge of their homelands, and are often entrepreneurial with business in their homeland. Also, they seek opportunities to transfer knowledge from their diaspora country to their home land [7]. Semi-structured interviews were carried out separately with the chairpersons of the two diaspora associations. The semi-structured interviews led to the definition of different types of goods that the chairpersons considered could have potential for local manufacture in their home countries. The chairpersons' opinions were based on their frequent dialogues with diaspora members and with frequent contacts in their home countries, as well as their own ongoing investigations about potential business opportunities. Then, information about moveable factories was provided to diaspora association members during their separate association meetings. Next members completed a structured questionnaire. Alongside a list of goods compiled with diaspora association chairpersons, the question asked was: what kind of business opportunity is mobile/moveable factory for making: ... There were a total of 25 respondents: 12 from Horn of Africa and 13 from West Africa. These were diaspora associations' members who have active interest in setting up businesses in their homeland and have up-to-date knowledge of demand and supply conditions.

The remainder of the paper comprises four sections: what goods should be produced; how lack of manufacturing skills and infrastructure can be overcome; relevance to global manufacturing objectives; and conclusions. Four global manufacturing objectives are considered. These are -shoring manufacturing; sustainable manufacturing, advanced manufacturing, and distributed manufacturing. The primary contribution to the literature is to explain how moveable factories can enable sustainable widespread modern manufacturing to be carried out by local people in regions without manufacturing skills and infrastructure. This contribution is relevant to scholars and practitioners in all countries seeking to increase employment and improve balance of trade. A second contribution is to the literature is explanation of how four global manufacturing objectives can be achieved better in practice with moveable factories. A third contribution is to the literature is to explain the potential of moveable factories better enable global manufacturing objectives in terms of three theoretical perspectives: Resource-Based Theory (RBT), Knowledge-Based View (KBV), and Transaction Cost Economics (TCE).

2. What goods should be produced

2.1. Types of goods

Research participants from Horn of Africa considered that the following types of goods could be made profitably with moveable factories: (1) leather goods, (2) housing blocks, bricks, lintels etc., (3) solar panels, (4) nails, bolts, brackets, handles, etc., (5) sheet roof panels, (6) fruit juice,

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