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Bhatt, Purva

Research Scholar of Department of Humanities and Social Sciences, Malaviya National Institute of Technology Jaipur

Singh, Manju

Faculty of Department of Humanities and Social Sciences, Malaviya National Institute of Technology Jaipur

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# Industry 4.0 and Sustainability- Leveraging Community Engagement for Achieving Partnership for Common Goals

Purva Bhatt<sup>1\*</sup>, Manju Singh<sup>2</sup>

<sup>1</sup>Research Scholar of Department of Humanities and Social Sciences, Malaviya National Institute of Technology Jaipur, India

<sup>2</sup>Faculty of Department of Humanities and Social Sciences, Malaviya National Institute of Technology Jaipur, India

\*Author to whom correspondence should be addressed:

E-mail: purvabhatt7@gmail.com

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**Abstract:** While the notions of Industry 4.0 are often conceptualized through strict disciplinary prisms, its ramifications however are trans-disciplinary. The follies from containing nuisances related to Industry 4.0 as matters of esoteric conundrums has already started surfacing in the academic discourses, as it has been widely acknowledged that the impact of Industry 4.0 reaches far beyond its disciplinary corridors to the grassroots communities. There have been increased scholarly researches arguing about the linkages between sustainability and Industry 4.0 especially in terms of its socio-economic implications. Further the fourth industrial revolution coupled with the onset of COVID 19 pandemic has routinized paradigmatic changes in everyday life of individuals that re-establishes the extended impact of Industry 4.0 on communities. The upcoming technological revolution that forms the foundational frame for Industry 4.0 contains countless opportunities and immense potential towards sustainable development of communities. Nevertheless, despite all the altruistic intentions there are evident loopholes wherein the benefits arising from the technological advancements in the domain of Industry 4.0 couldn't percolate to the grass-root level to provide aid to those already distressed. This paper asserts that the essential reason for this is the dominance of private corporates in the Industry 4.0 processes whose Benthamian principles of cost benefit analyses often results in excluding of community aspirations from the present technological development in Industry 4.0 framework. The paper thus argues that in order to ensure sustainability of Industry 4.0 it then becomes indispensable to make community not just mere beneficiaries but partners in process. In such backdrop, the paper discusses that the renewed role of Technological institutes of higher education as that of a catalyst. The institutes by embracing deeper engagements with the community can assume the role of critical public institutions and therefore can become a kingpin between industry and communities. Such partnerships for common goals (SDG -17) between industry, community through academia can lead towards mutually beneficial results for all the stakeholders and simultaneously ensuring sustainability.

**Keywords:** Industry 4.0; Higher Education; Sustainability; Community Engagement; SDG-17 Partnership for Goals

## 1. Introduction

Humanity across the globe and the entire planet Earth is facing disruptions. Up until the relevance of sustainability might have been perceived too distant in the future. However, the ongoing pandemic has exposed humankind's extreme vulnerabilities and prompted the leaders to rethink, reanalyze, and give a sensible turn to the concept of sustainability both at global and local levels<sup>1</sup>. The pandemic caused by the COVID-19 has again validated how interrelated and interconnected the entire

world society is. It has brought into the consensus that one can change the present state of distress and reimagine the common futures through collective action which mandates sustainable partnerships for common goals.

In such background, the domain of Industry 4.0 cannot be placed in water tight disciplinary compartmentalization, due to its trans-disciplinary implications. In such background lucid linkages between Industry 4.0 and Sustainable Development comes to the fore. Industry 4.0 though lays its gravitas in technological interventions, the involvement of communities viz. human capital in this

process, can't be alleged as exclusive domain that affects just the labor market but is one that equally affects the social dimension of sustainable processes<sup>2)</sup>. Further the implication of processes on the impacted communities cannot be treated as a mere ancillary function, but central element for decisions to be taken in the context of Industry 4.0. The upcoming technological revolution that forms the foundational frame Industry 4.0 contains countless opportunities and immense potential towards sustainable development of communities<sup>3)</sup>. Thus it becomes prominent to examine Industry 4.0 within the larger framework of sustainability. Synergies between Industry 4.0 and sustainability can reap mutually advantageous results both for industry and community as it can result in creation of sustainability driven models in Industry 4.0 ecosystem wherein emerging technologies could be development, diffused and transferred after sieving it through sustainability framework.

Nonetheless the present Industry 4.0 ecosystem is dominated with private corporates which not only lead but also determine the direction of future technological advancements. This has upraised two crucial concerns. *First*, as markets as driven by core values of profit based on Bethamian principles, it leads to development of technologies and knowledge in Industry 4.0 framework that primarily focus on market values<sup>3,4)</sup> and keeping issues of community good on the periphery. *Second*, due lesser participation of public institutions in Industry 4.0, which are also considered archetypical institutions for promoting public good, the aspirations and ambitions of community are excluded in the process.

Such domination of markets in the present Industry 4.0 discourse thus lead to decision making models that eludes sustainability framework and thus ignores the unintended/intended ramifications on the community<sup>5,6)</sup>. *Second* it leads to usurpation of community's authority as community's ambitions, aspersions and apprehensions from the Industry 4.0 often doesn't reaches the decision makers. *Third*, due to the lack of technical capacity of the community members, the benefits arising out of Industry 4.0 also seldom reaches the grassroots<sup>7)</sup>.

In such background the role of institutes of knowledge production like Technological Institutes of Higher Education (TIHE) as play a crucial role in ensuring sustainability in Industry 4.0 framework. Considered as archetypical institutions for public good, technological institutes of higher education by embracing deeper engagements with the community can assume the role of critical public institutions and therefore can become a kingpin between industry and communities. Nevertheless, to realize assume the role of catalyst, present-day TIHE needs to be revamped to achieve transformational benefits for common goals. This requires overhauling in the present-day mission of TIHE that excessively focusses on market values to one that is rooted in the commonly neglected values and ethos of mutual benefits, inclusivity, partnership, collaboration, mutual respect, and social

justice, which is synonymous to the community engagement approach. Technological institutes of higher education by mainstreaming community engagement approach can then create partnerships for common goals (SDG -17) between industry, community through academia can lead towards mutually beneficial results for all the stakeholders and simultaneously ensuring sustainability in Industry 4.0. As it will foster sustainability ecosystem within Industry 4.0 that can aid in achieving socially beneficial targets such as achieving circular economy paradigms, sustainable supply chains and value chains and development of novel sustainable business models. Such multi-stakeholder partnership between TIHE, community and industry nudge technological institutes of higher education fulfil its social responsibility, community to become partners in decision making and industries to base their decision making models within the larger sustainability framework.

## 2. Review of Literature

### 2.1 Industry 4.0 and Sustainability

Industry 4.0 can be conceptualized as "the set of technologies, devices and processes [...] capable of operating in an integrated way along the several phases of the production process and along the several levels of the supply chain [...] that allow for self-sufficient production, integrated operations, decentralized decisions, minimum human intervention"<sup>8)</sup>. It embraces structures, systems and processes that lays increased gravitas on advanced technologies such as Internet of Things, Virtual and Augmented Reality, cognitive robotics, cloud computing, blockchain technologies, cyber physical systems, big data analytics, digital twins and additive manufacturing (three-dimensional printing)<sup>8,9)</sup>.

There have been several researches on mapping the interlinkages between industry 4.0 and Sustainability<sup>10)</sup> but through disciplinary prisms which tend to overlook social dimension of sustainability. Nonetheless technologically driven nature coupled along comparatively early stage of Industry 4.0 technologies lifecycle brings to the fore various concerns which<sup>2,5,11)</sup> outline in triple bottom line categorizations-

- i. *Economic Consequences*- It includes the cost-intensive nature and complications in assessment of financial gains as well as economic effectiveness
- ii. *Environmental Consequences*- It may include concerns such as intensification of e-waste, proliferation of energy consumption<sup>12)</sup>; deforestation and environmental degradation due to industrialization and unsustainable economic decisions<sup>10,13)</sup>
- iii. *Social Consequences*- These may include subtle impact on the communities which may arise out of intended or unintended use of technology<sup>13)</sup>. Issues such as human-robot interaction issues,

unemployment threats, privacy concerns may be seen as few of the social consequences.

Therefore, it becomes essential to examine the context of Industry 4.0 within the larger sustainability framework, as the impact of Industry 4.0 percolates far beyond its disciplinary conundrums to the level of community, it becomes prominent to examine Industry 4.0 within the larger framework of sustainability. There have been academic researches that have established empirical links between IR 4.0 and sustainability<sup>14-18</sup>. Nonetheless, the social dimension of Industry 4.0 though prominent but often escapes academic heed<sup>18</sup>. Thus while sustainability could be operationalized in terms of economic, environmental, social, this paper considers the social dimension of sustainability in context of Industry 4.0. In the analysis for the present piece of research, seventeenth sustainable development goal (SDG 17) - Partnership for Goals is examined in relation to Industry 4.0.

## 2.2 Sustainability- Partnerships through Common Goals

Sustainability could be classically be defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (Brundtland Commission, 1987), thus highlighting the need of inter-generational equity through integration of economic, environmental and social concerns in in policy and prominent decision making<sup>12,19</sup>. These three aspects of sustainability are independent phenomena and thus require for synergetic efforts in congruence with Industry 4.0. This paper synergies the seventeenth sustainable development goal (SDG -17) with technology driven Industry 4.0. SDG 17- Partnership for Goals reiterated the importance of partnerships in the achievement of the SDGs, and for mobilizing knowledge, expertise, and technologies for development<sup>20</sup>. It lays increased gravitas on creating collaborative, multi-stakeholder partnerships at academic/ non-academic levels, local, national, international levels, and also trans-disciplinary levels for the mutual benefit of all its partners<sup>21</sup>.

## 2.3 Community Engagement in TIHE

Historically, technological institutes of higher education has played the role of archetypical public institutions keeping the goals of community benefit at its core, nonetheless, the corporatization of institutes of knowledge creation viz TIHE has drifted them away from their social responsibility<sup>21</sup>. In the milieu of present technological change in the Industry 4.0 framework, it has become more important than ever to consider the social implications of technologies on the community. In this context, the technological institutes of higher education can play a prominent role of kingpin between industry and community. TIHE by overhauling their present practices and Community Engagement Approach can foster sustainability in education, community and industry.

Community Engagement is classically defined as “collaboration between institutions of higher education and their larger communities (local, regional/state, national, global) for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity”<sup>22-24</sup>. Community Engagement approach focuses on creation of mutually respectable and beneficial partnerships of academia with both its internal and external stakeholders that can facilitate achievement of common goals<sup>21,22</sup>.

This paper will explore how mainstreaming community engagement in technological institutes of higher education can foster multi-stakeholder partnerships for common goals that facilitate in achieving mutual benefits to TIHE, industry and community and thus ensuring overall sustainability in Industry 4.0.

## 3. Research Methodology

The paper is a conceptual paper which are essentially perceived as powerful means of theory synthesis that can “bridge existing theories in interesting ways, link work across disciplines, provide multi-level insights, and broaden the scope of one’s thinking”<sup>25</sup>. This paper typically draw on multiple concepts, literature streams, and theories that play differing roles. It starts from a focal phenomenon that is the issue of Industry 4.0 and sustainability. Though this phenomenon is observable but not adequately addressed in the existing research, especially the social dimension of sustainability in Industry 4.0 processes. Therefore the authors have inductively identified differing conceptualizations of this phenomenon through trans-disciplinary lens, and then argued that such a lacunae can be best addressed in through the particular domain theory of Community Engagement. As a consequent result the paper proffers a conceptual framework of linking the observable phenomenon of Sustainability and Industry 4.0 with domain theory of community engagement. This could be succinctly outlined through following steps-

- Identifying the focal phenomenon
- Differing conceptualizations of this phenomenon based on the Domain Theory
- Proposing new relationships among constructs and thus framing conceptual framework
- Thus to discuss logical and complete arguments about these associations between Industry 4.0, Sustainability and Community Engagement.
- Through such methodology the paper will attempt to explicate the role of each construct by developing logical and thorough arguments about these associations and thus proffering expanded explanations.

## 3. Conceptual Framework

The interconnected, interrelated and trans-disciplinary nature of technological revolution within the ambit of

Industry 4.0 calls for multi-stakeholder partnerships between various institutions and agencies. The SDG-17, Partnership for common goals mandates creation of successful public, public-private, and civil society partnerships for achievement of sustainable agendas, and thus encourages trans-disciplinary partnerships. It stresses on the significance of partnerships and collaborative networks in the attainment of the SDGs and thus nudges for mobilization of resources, skills, expertise, knowledge and technologies for development agenda.

### 3.1 Synergizing Industry 4.0 with SDG-17

The SDG-17 in terms of Industry 4.0 can be contextualized through the below mentioned pointers–

*Target 17.6 Knowledge Sharing and Cooperation for Access to Science, Technology and Innovation-*

The creation of triangular collaborative network between industry, community and academia (TIHE) can facilitate enhanced knowledge sharing between the three on mutually agreed positions and can further facilitate in improved coordination through already existing mechanisms.

*Target 17.7 - Promote Sustainable Technologies to for the benefit of communities-*

This could translate as promoting development, transfer, dissemination, and diffusion of socially, environmentally and economically sustainable technologies viz. green technologies. Such decisions will take into perspective the market profitability along with the benefits that it caters to the community. Technological institutes of higher education as an enabler can promote socially just technologies and as a catalyst can ensure check the unintended ramifications of such technology on community.

*Target 17.H - Encourage Effective Partnerships between academia, industry and community-*

The collaborative network between industry, community and TIHE can facilitate building upon the experiences, wisdom, adroitness and resources each partner brings. While the academic knowledge and institutional resources can be channelized for socially relevant knowledge and fulfilment of institutional responsibility, communities can route their aspirations, aspersions and apprehensions through this network, and the industries can utilize this knowledge and place their processes within larger framework of sustainability.

This way the triple helix network between academia, industry and communities are structured upon mutually beneficial goals, values and principles which essentially requires “placing people and the planet at the core”<sup>21)</sup>. This could not be more effectively justified than during the COVID-19 pandemic, when the need for deeper partnership among nations, regions, and local communities is felt more than ever. As a consequence, in order to address the burgeoning scourge of COVID - 19 pandemic, collaborative partnerships for common goals were assumed not only a moral obligation, but an

indispensable requirement to ensure benefit for all. In such a background such multi-stakeholder partnerships can prove to be a catalyst in achieving sustainable development in Industry 4.0 as well as channelizing benefits arising from Industry 4.0 to the most vulnerable communities.

### 3.2 Achievement of SDG-17 through Community Engagement in TIHEs

Community Engagement in TIHEs implies collaborative interactions between universities and communities<sup>22)</sup>. It dispenses from typical outreach or extension roles in preference of a more participatory approach focused on knowledge generation and exchange. As a result, it takes the form of novel methods to knowledge co-construction that connect communities to universities through student engagement in community-based projects or knowledge-based movements<sup>26)</sup>. It nudges higher education institutions to alter their missions beyond degree providers and become catalysts for change. As critical public institutions technological institutes of higher education by facilitating multi-stakeholder partnerships can appropriate their socio-economic goalmouths in congruence with public good. As partners with stakeholders both within and beyond the academic circumference, TIHE can facilitate co-creation of knowledge, development of technologies, and mobilization of resources and creation policies that mutually benefits all the stakeholders in the collaborative network.

In the aforementioned backdrop integration of community engagement mainstreamed by technological institutes of higher education can be categorized into five functions which if put in the Industry 4.0 framework could mean-

*Co-learning with community and industry stakeholders:* This could mean utilizing the technological knowledge, essential skills and benefits arising from Industry 4.0 by TIHE to build the capacities of the grassroots communities and thereby increasing their bargaining power in the Industry 4.0 decision making matrix.

*Co-creation of technological knowledge through research with community and industry stakeholders:* Such endeavors would comprise of multi-stakeholder research projects between TIHE, industry and communities based on mutually respectable partnerships for common goals. Such research would build upon the capacities, resources and knowledge each stakeholder brings to the partnership.

*Knowledge dissemination with community and industry stakeholders:* TIHE as kingpin between community and industry can disseminate the technological innovations to community and voice the concerns from implications of any such technologies to the industry. Such democratization of processes can contribute to overall sustainability achieved through partnerships for common goals.

*Breaking the disciplinary silos including “non-academic” in the academic discourse:* The multi-stakeholder and trans-disciplinary partnerships between academics, industry and community can enrich the existing academic scholarship with experiential knowledge, wisdom and skills that community scholars and industry holds in its ambit. This will thus usher TIHE to devise curriculums, pedagogies and courses in congruence with stakeholders’ aspirations and with the core aim of benefit to the community. It’ll further promote involving community scholars, industry practitioners to co-teach in TIHE along with other academic faculty and thus enrichen the overall sustainability of technological knowledge creation while simultaneously routing the technological benefits rising from Industry 4.0 for the benefit of academia and consequently community.

*Promoting Praxis for Social Change:* As one of the key elements of CE, Praxis<sup>27)</sup> can contribute towards both action and reflection. It can sensitize stakeholders towards community issues and nudge them to develop technologies, undertake projects and develop decision making models that contribute towards community’s benefit and consequently socially validating academic knowledge as well as ensuring sustainability of Industry 4.0 processes.

The technological institutes of higher education by mainstreaming community engagement through their institutional vision, teaching, learning, research, service learning/ outreach functions can foster a collaborative network of multi stakeholder partnership for common goals. Such partnerships between academia, community and industry can reap mutually benefits for all its stakeholders. This will consequently lead to recalibration of Industry 4.0 processes by placing it within the larger framework of sustainable development goals. The benefits of such multi-stakeholder arrangements may reap gains for industry, community and TIHE.

*For Industry 4.0-* it could facilitate attaining sustainability which could be translated as –

- Achieving paradigms of circular economy, development of sustainable models of business, creation of sustainable supply and value chains, embracing sustainable socio-environmental processes, achieving sustainable product life cycle, ushering sustainable smart manufacturing paradigms.
- The collaborative benefits arising from the partnership can help in bringing the industry-community-academia gap, co-creation, exchange of technological knowledge, reaching economies of scale, fair cost distribution paradigm et. al.
- It will further lead to development of emerging technologies that are conceptualized and designed on sustainability principles.

## 4. Conclusion

As envisioned by the United Nations Sustainable Development Goals for 2030, technological advancement is carries the problem of transitioning from traditional technological ecosystem to modern intelligent machines whilst preserving the sustainability of Industry 4.0<sup>11)</sup>. Industry 4.0 clasps upon surfeit opportunities to ensure attainment of sustainability, viz. the usage of modern technologies like augmented, virtual reality, robotics or artificial intelligence if applied with reoriented social aims to sectors such as supply chains, manufacturing can have significant socio-economic and environmental impacts like reduction in environmental footprints of a product, service or processes, it can usher connectivity of technology with resources and lead towards sustainability benefits like reduction in greenhouse gas emissions, pollution, efficient energy consumption and together with better economic and social profits. The potential of Industry 4.0 for realizing socio-economic and environmental sustainability are still less researched due to its relatively initial phase of implementations.

Nevertheless, while Industry 4.0 embraces a plethora of opportunities within its ambit it also carriers concerns which if left unattended may sabotage the benefits. The practice of ponderation on the issues of sustainability cannot be further smeared by decision makers through tokenistic approach or greenwashing<sup>28)</sup>. The covid-19 induced pandemic has uncovered the social, environmental and economic ramifications resulting from putting sustainability framework in separate disciplinary conundrums. In this milieu, the creation of trans-disciplinary, multi-stakeholder partnerships between industry, academia and community can contribute towards overall sustainability of Industry 4.0 wherein academia as kingpin between industry and community can aid in fulfilment of mutually common goals and democratize the benefits arising from development till the most vulnerable sections of community.

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