Technology Modernization of India Post using Unified Theory of Acceptance and Use of Technology: A perspective-based evaluation of recent initiatives revering United Nations' Sustainable Development Goals

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Abstract: As digital disruptions impose greater demands on IT systems and organizations, companies must consider an end-to-end approach for upgrading and managing business technologies. The proposed research aims assessing the perspective of relevant stakeholders on the recent initiatives held on behalf of technology modernization in postal and allied services. The recently held initial study on same perspective on postal study exhibited about 81 percent of the variance in behavioral intention to use a technology and about 34 percent of the variance in technology use. In the three phased research with Initial field screening in 6 Megacities' key authorities housed at CPMG headquarters. SDGs found held on have been included in development of research instrument. The study's robustness includes a large sample size across the megacities of India bringing a holistic view. Initial solution ahead had been a progressive study held across 6 megacities, with a sample of 1200. Final results have many significant findings to overture. The study will be having significant business and social applications across the vast stretches of developed and developing world, in addition to financial strength and robustness.

Keywords: Technology Modernization; India Post; UTAUT; Customer Centricity; UN-SDGs.

Introduction

As digital disruptions impose greater demands on IT systems and organizations, companies must consider an end-to-end approach for upgrading and managing business technologies. Hence, we taken an objective the assess the relevance and opalization of alike initiative in department of posts. The **unified theory of acceptance and use of technology** (**UTAUT**) is a technology acceptance model formulated by Venkatesh and others in "User acceptance of information technology: Toward a unified view" (Venkatesh et al., 2003). The UTAUT aims to explain user intentions to use an information system and subsequent usage behavior. The theory holds that there are four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions. The first three are direct determinants of usage intention and behavior, and the fourth is a direct determinant of user behavior. Gender, age, experience, and voluntariness of use are posited to moderate the impact of the four key constructs on usage intention and behavior. Subsequent validation by Venkatesh et al. (2003) found it to account for 70% of Behavioral Intention to Use (BI) and about 50% in actual use (Koivimäki, Ristola, Kesti).

Problem Statement

"Technology Modernization of India Post using Unified Theory of Acceptance and Use of Technology: A perspective-based evaluation of recent initiatives revering Sustainable Development Goals"

The proposed research aims at assessing the perspective of relevant stakeholders on the recent initiatives held on behalf of technology modernization in postal services and allied activities of department of posts, referring to UTAUT technology upgradation and customer satisfaction. Following are the objectives:

- To explore the UTAUT model applicability in technology enabled postal services in India
- To examine the stakeholders' outlook on technology modernization in postal and allied services
- To assess the policies and procedures alignment with UN-SDGs from stakeholders' perspective

In depth details have been discussed in upcoming sections, using following model validated:

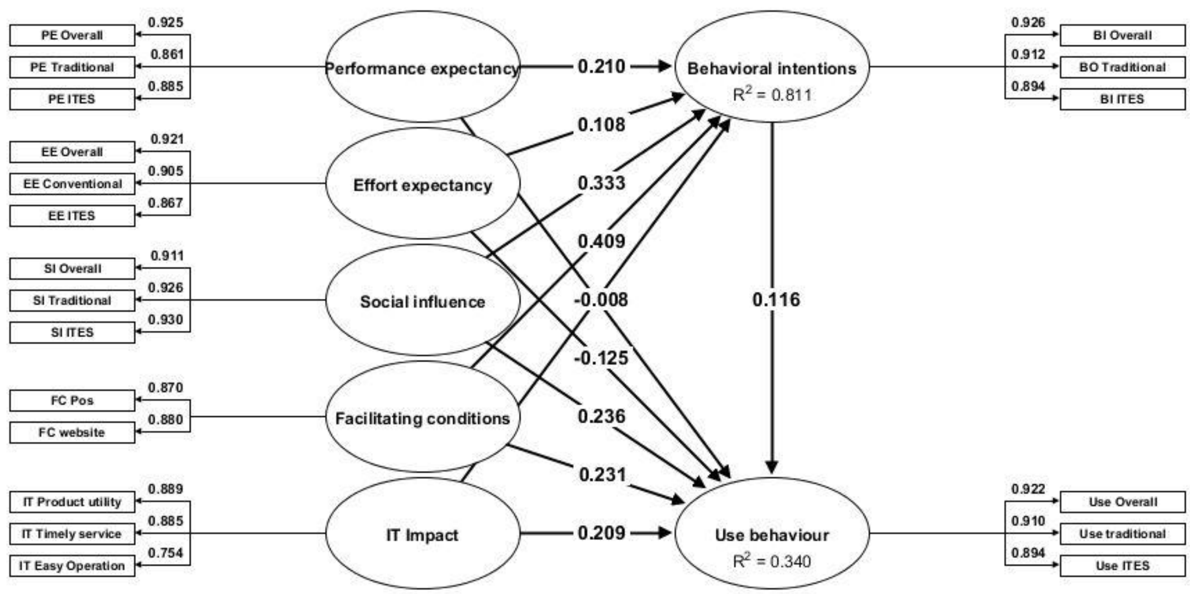

Figure 1. Model tested in Initial study held earlier as a foundation of present research.

Related work

Literature has been presented in three columns, whereas postal services been the first references, with customer satisfaction and UTAUT being the second and third in the loop. Further in-depth literature review will help to finely categorize and summarize the findings to highlight patterns, trends, or relationships. Very lesser studies have been conducted on postal sector in India. A few studies have been found held abroad, on the postal or courier services of respective country. Previous study results slightly contravene the existing text, whereas instead of UTAUT explained about 70 percent of the variance in behavioral intention to use a technology and about 50 percent of the variance in technology use, the recently held initial study on same perspective on postal study exhibited about 81 percent of the variance in behavioral intention to use a technology and about 34 percent of the variance in technology use. Coming forth to the study in particular, following is the description of past literature in brief.

The **unified theory of acceptance and use of technology** (**UTAUT**) is a technology acceptance model formulated by Venkatesh and others in "User acceptance of information technology: Toward a unified view" (Venkatesh et al., 2003). The UTAUT aims to explain user intentions to use an information system and subsequent usage behavior. The theory holds that there are four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions. The first three are direct determinants of usage intention and behavior, and the fourth is a direct determinant of user behavior. Gender, age, experience, and voluntariness of use are posited to moderate the impact of the four key constructs on usage intention and behavior. The theory was developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain information systems usage behavior. Subsequent validation by Venkatesh et al. (2003) found it to account for 70% of the variance in Behavioral Intention to Use (BI) and about 50% in actual use (Koivimäki, Ristola, Kesti).

Understanding individual acceptance and use of information technology is one of the most mature streams of information systems research (see Benbasat and Barki 2007; Venkatesh et al. 2007). There have been several theoretical models, primarily developed from theories in psychology and sociology (for a review, see Venkatesh et al. 2003), employed to explain technology acceptance and use. A review and synthesis of eight theories/models of technology use resulted in the unified theory of acceptance and use of technology (UTAUT; Venkatesh et al. 2003). There have been many applications and replications of the entire model or part of the model in organizational settings that have contributed to fortifying its generalizability (e.g., Neufeld et al. 2007). There are three broad types of UTAUT extensions/integrations. The first type of extension/integration examined UTAUT in new contexts, such as new technologies (e.g., collaborative technology, health information systems; Chang et al. 2007), new user populations (e.g., healthcare professionals, consumers; Yi et al. 2006) and new cultural settings (e.g., China, India; Gupta et al. 2008). The second type is the addition of new constructs in order to expand the scope of the endogenous theoretical mechanisms outlined in UTAUT (e.g., Chan et al. 2008; Sun et al. 2009). Finally, the third type is the inclusion of exogenous predictors of the UTAUT variables (e.g., Neufeld et al. 2007; Yi et al. 2006). Our review revealed that most studies using UTAUT employed only a subset of the constructs, particularly by dropping the moderators (see Al-Gahtani et al. 2007; Armida 2008). Literature on the criterion (Megacities) and variable (Sustainable Development Goals) has been compiled:

MEGACITIES

Zhanga, Wilson, MacDonald, Zhang, and Yua (2020) mentioned that twenty of the 33 megacities included densely, moderately and sparsely populated areas with unique PM2.5 values that spanned more than 50 polygons. The graphs for these 20 cities reproduced in Fig. 4 show that the PM2.5 concentrations in densely populated areas are higher than those in moderately and sparsely populated areas.

Kourtit, and Nijkamp, P. (2013) argues that in the historical evolution of cities, large-scale urbanization is not only a fact, but a necessary outcome of the forces of globalization and competition. Almost half a century ago Gould (1963) wrote an interesting article in which he argued that the long-run location patterns of human activity were the result of a rational choice process in the struggle of man against the environment. Spatial locational choices are apparently realized in a complex and dynamic force field, in which the interactions between climate and environmental change, demography, economic motives, and social drivers play a prominent structural role within the new global economic landscape (Kourtit, Nijkamp, Lowik, van Vught and Vulto 2011). Global megacities and urban agglomerations are certainly major sources of changes in land use and land cover, and they are major users of their resources. This means that a shift in urban policy and urban governance is fundamental and necessary (Naess 2001; Tamagawa 2006; Slavin 2011). At present, more and more people are moving from rural areas to cities, mostly drawn by the interaction of socio-economic dynamics as the result of a mix of various push-factors, for example, unemployment, low standards of housing and infrastructure, lack of educational facilities (Massey et al. 1993; EEA 2006; UNFPA 2007) and pull-factors, for example, economic opportunities, attractive jobs, cultural attractiveness, better education, modern lifestyle (Portes and Böröcz 1989; Portes 1995; Rodriguez et al. 1998; Deurloo and Musterd 1998; Bodaar and Rath 2005; Lardiés Bosque and Castro Romero 2002; Favell 2002). The minimum size of a megacity is usually supposed to range from 4 to 10 million in habitants, depending on the source (Daniels 2004). However, the findings show that in 2050 Africa and Asia are still expected to have lower levels of urbanization than Latin America and the Caribbean, and the more developed regions such as Australia, New Zealand and Northern America (United Nations 2011). The expected concentration of human capital in urban agglomerations–with more skilled, creative and educated people–will make urban agglomerations power houses of economic growth (Hanushek and Kimko 2000; Krueger and Lindahl 2001; Castello and Domenech 2002). They shall most likely witness an unprecedented urban dynamic, with a transition from early 'island cities and hierarchical cities towards global megacities, network cities, and even city networks, together with the emergence of Village cities and e-cities as complementary spatial constellations (Kourtit, Nijkamp, Lowik, van Vught and Vulto 2011). For a precise definition of such concepts, they refer to Gregory et al. (2009). The process of structural urbanization is still continuing, with degrees already exceeding 75 per cent in various European countries and elsewhere (Mega 2010; United Nations 2011). It is noteworthy that the findings indicate that between 2011 and 2050 the world population will increase by 2.3 billion, rising from 7.0 billion to 9.3 billion (United Nations 2011). Consequently, modern urbanization means not only a shift from rurality to urbanity but also the emergence of large-scale urban agglomerations which ultimately turn into mega-cities (Nijkamp 2010). Cities have turned into force fields with both centripetal and centrifugal movements in an open world, an observation which was already made a few decades ago by Dematteis (1988). Especially the seminal work of Friedmann (1986) on world city developments has inspired much research on globalization and urban development (Beaverstock et al. 1999; Knox and McCarthy 2005; Sassen 2006; McCann 2008; Kourtit et al. 2011). According to recent population predictions (United Nations 2010), our planet will have to accommodate 9 to 10 billion people by the year 2050 (Kraas 2006; World Bank 2006). According to the United Nations (2011) there will likely be more than 25 global megacities with a population above 10 million by mid-century. It should be emphasized here that cities and urban agglomerations can boost an enormous rise in efficiency and productivity (Duranton and Puga, 2004), as a consequence of a wealth of various externalities (Nijkamp 2008; de Groot et al. 2009). Consequently, cities are able to create so many positive external benefits, that from an economic perspective (Owen 2009; Glaeser 2011). In the 'new urban World' (Kourtit, Nijkamp, Lowik, van Vught and Vulto 2011), increasing urbanization will likely continue as a robust trend. Cities will become the 'home of man' (Ward 1976), and will gradually meet strict sustainability conditions. Indeed, urban productivity is key for urban performance. In an OECD study (2006) it was shown that productivity per worker outstrips all other factors in performance comparisons of cities. Besides agglomeration externalities, there are also additional drivers of a relatively high urban productivity, that is, the urban knowledge base and the level of ICT use in a city (Henderson 2003). Legal and valid one enhances the efficiency in the dynamic allocation of production factors and has generally a positive impact on local economies (Nijkamp et al. 2012). Migration is a typical urban phenomenon, especially if the trend towards global knowledge migration continues (OECD 2009). It seems plausible however, that a migration influx will have a positive influence on the economy of cities and shapes life for developing countries (World Bank 2009).

Folberth, Butler, Collins, and Rumbold (2015) examine megacity impacts on atmospheric composition and climate. The impacts of urban agglomerations have been subject to numerous modelling studies and observation campaigns (White et al., 1976; Hov et al., 1978). The potential of large cities to contribute significantly to air pollution over large distances, even up to the hemispheric scale, has also been established (HTAP, 2010). The largest cities in the world have been labelled “megacities” (UN, 2006). In a paper published in 1950 Vere Gordon Chlide defined a human settlement to qualify as a “city” by applying ten general metrics that essentially reflect the trend to an increasing population density which were accompanied by a high degree of differentiation and specialization in occupations (Chlide, 1950). With this definition in mind, they can say that the first cities appeared after the Neolithic Revolution in Mesopotamia and Egypt nearly 10,000 years ago (Davis, 1955). The 2007 UN report “UNFPA state of world population 2007 - Unleashing the potential of urban growth” (UNFPA, 2007) has argued that this trend to global urbanization is inevitable and likely to continue in the future. Cities of this size are called “mega-cities” (UN, 2006). The concept of the “ecological footprint” (Rees, 1992), in essence, is the size of area that is required to sustain the megacity population. A detailed discussion can be found in Rees (1992) and on the internet. To give an example, the Tokyo metropolitan area extends over 2188 km2 with a total population of 13,189,000 inhabitants amounting to a population density of 6028/km2 (Tokyo Metropolitan Government, 2011). Assuming a biocapacity of the Earth of 1.8 persons per hectare, the Tokyo metropolitan area would require 237,402 km2 or roughly two thirds of Japan to sustain itself. Important pollutants such as ozone and particulate matter typically exhibit atmospheric lifetimes in the range of a few hours up to a few weeks (Seinfeld and Pandis, 1998). In a study by Lawrence et al. (2007) two different types of metrics have been applied to quantify the export of pollutants from megacities. Guttikunda et al. (2005) defined the ambient chemical footprint of a megacity to assess the impact of a particular species on atmospheric composition within a certain distance of the emission source. While studies of pollution outflow and long-range transport on the global, continental and regional scale are relatively numerous (Akimoto, 2003; Heald et al., 2003; HTAP, 2010; Pfister et al., 2005) similar efforts assessing the emissions from megacities and large population centers are much less available. Molina, M.J. and Molina, L.T. (2004) published a critical review on megacities and atmospheric pollution which appears to be the first study to draw a connection between megacities and atmospheric pollution. The first study on the effects of urban emissions on global air quality was published by Mayer et al. (2000). Around the same time, a small number of studies analyzed specifically the impact of megacities on air quality on the regional scale (Gurjar et al., 2004; Guttikunda et al., 2005). The impact of megacities on the global scale was first examined in a series of modelling studies focusing on global atmospheric dispersion of pollutants (Lawrence et al., 2007) and global atmospheric chemistry (Butler and Lawrence, 2009; Butler et al., 2012). The potential impact of megacity emissions on the climate system was summarized in

Folberth et al. (2012). MEGAPOLI was a pan-European project that included a total of 23 research groups from 11 countries (DMI, 2011). More project details and a comprehensive list of publications can be found on the CityZen web page (CityZen, 2011). MILAGRO campaign was aimed at conducting measurements of pollutants and other trace gases and particulate matter (MILAGRO, 2006). The emission of nitrogen oxides, carbon monoxide and volatile organic compounds produces ozone in the troposphere (Haagen-Smit,1952; Logan et al.,1981; Seinfeld and Pandis, 1998) and consequently leads to the formation of hydroxyl radical which determines the oxidation capacity of the atmosphere (Levy II, 1971; Warneck, 1974; Lelieveld et al., 2004). With the timescale of effective inter-hemispheric mass exchange of the order of 1 year (Newell et al., 1969; Maiss et al., 1996).

Johannessen, Saini, Zhang, and Harner (2022) measured various tire-derived contaminants semi-quantitatively in archived extracts of passive air samplers deployed in 18 major cities that comprise the Global Atmospheric Passive Sampling Network (GAPS-Megacities). Analysis was done on archived samples, which represent one-time weighted passive air samples from each of the 18 monitoring sites.

Xu, Xiu, Li, Liang, and Jiao (2021) adopted the NASA's Black Marble NTL data with a daily resolution to investigate their spatio-temporal changes. A megacity usually refers to a city residing more than ten million people (Demographia, 2020; Nations, 2015). They excluded the majority of Asian megacities. Cities with poor data quality were excluded (Hale et al., 2021). They collected locations of city centres from The Atlas of Urban Expansion (Angel, 2016). They also collected the urban extent of each sample city from the Atlas of Urban Expansion (Xu et al., 2020).

Cohen (1993) synthesizes to use improved communications to reduce the importance of downtown proximity and locational advantages that led to the urban concentration of economic activities in earlier periods. Shortages of clean water, uncollected garbage, and heavily polluted air have begun to have direct visible consequences on the health and productivity of urban populations, as documented in the World Development Report 1992.

Razvadauskas offer an overview of the current economic and demographic state of the world's megacities. In 2017, 26 of the 33 megacities were in developing countries. Developing countries will dominate the megacity scene over 2017–2030, adding five of the six new megacities in the period.

Bourdeau-Lepage, and Jean-Marie quotes that more generally the cities with more than 5 million inhabitants, namely the "large urban agglomerations", the number of which has been multiplied by six between 1950 and 2005 (UN, 2004). These global cities, also called world cities or world metropolises have been analyzed by Hall (1966), Friedman (1986), Sassen (1991, 2000), Lacour (1999) and Bourdeau-Lepage and Huriot (2005) and have been identified and measured in particular by Taylor (2004) and the Globalization and World Cities (GaWC) group and network. In 1950, there were two megacities: New York and Tokyo. India, Nigeria and Bangladesh have less than one (International Communication Union). The number of telephones is less in whole Africa than in Manhattan (Wackermann, 2000). Without social connectivity, no global coordination. Institutions are a decisive factor. Bairoch (1988) emphasizes the "urban inflation" of the Third World. Sassen (1991, 2000) stresses the emergence and growing domination of global cities. It makes possible the participation to strategic economic decisions, and permits a better economic integration (Bourdeau-Lepage, 2005). City globalization may well be a factor of growth of a new kind of inequalities, not only between cities, but between nations, and can contribute to the formation of a “new geography of centrality and marginality” (Sassen, 2000). Finally, the mega-global divergence is related to the level of development of the countries where megacities are located, which seems to confirm Polese position that cities are the products of national economic growth (Polese, 2005).

Kraas (2008) concentrates on major risks and gives examples of environmental hazards and man-made hazards. The major reasons for increasing disaster-related fatalities and damages, even if the frequency of geophysical events remains unchanged and despite a number of efforts for disaster reduction (Smith 1996, p. 36ff.), Population growth, Rural land pressure (Kasperson, Kasperson & Turner 1995), Urbanization, Inequality, Climate change, Political change, Economic growth, Technological innovation, social expectations (Laquian 1994), Global interdependence.

Saier, Jr. (2007) indicate that for the urban U.S. population, a majority of food products travel over a thousand miles before reaching the consumer. Recently, B.R. Gurjar (The Financial Express, 44, p. 6, 2005) published an article entitled “Mega Cities: City-States of the Future.” Gurjar defines a megacity as one that has a population of over 10,000,000.

Desai (2020) aims to assist Indian policymakers in working towards an optimal population density for the country’s urban agglomerations, and in developing a disaster response strategy for these megacities beyond the current pandemic.

Li, Ma, Cheng, van Genderen, and Shao (2019) reviews the formation of megacities and summarizes the main problems, challenges and opportunities faced by the sustainable development of such large megacities (Urbanization 2016a, 2016b). The pace of urbanization is still accelerating around the world, so the twenty-first century is often called the century of the city (De Rynck et al. 2005; Nature 2010). In urban central districts, high-density architecture and the reduction of green coverage have seriously deteriorated the urban environment and at times, have caused an urban ecological imbalance (Su et al. 2016). Dense populations and industrial pollution have seriously damaged urban eco logical environments, as shown by Chan and Yao and many others (Chan and Yao 2008; Hong et al. 2015; Su et al. 2016), causing some problems such as environmental pollution (Chen, Chen, and Fath 2014b), heat island effect (Zhou et al. 2016), urban waterlogging (Quan et al. 2010) etc. New York City has successively launched many city plans, and the trend is from city planning to regional planning, to the construction of satellite towns, and ultimately to the formation of a regional sustainable city rather than a simple expansion like the ‘pie’ (G. L. 1932). The evolution route of the planning strategy at different stages in New York City, which can show the development through satellite imagery (Kowsky 1987).

Jean-Marie, and Bourdeau-Lepage (2006) looks coarsely on the institutional hypothesis. The mega-global divergence is directly or indirectly related to the level of development of the countries where megacities are located, which seems to confirm Polese position that cities are the products of national economic growth (Polese, 2005). The avenue suggested in this paper might be conducted further and more deeply. A number of studies show that global cities differ from one region to the other in the world, in terms of functional specialization (Taylor, 2003). The phenomenon concerns more generally the cities with more than 5 million inhabitants, namely the “large urban agglomerations”, the number of which has been multiplied by six between 1950 and 2005 (UN, 2004). These global cities, also called world cities or world metropolises have been analyzed by Hall (1966), Friedman (1986), Sassen (1991, 2000), Lacour (1999) and Bourdeau-Lepage and Huriot (2005) and have been identified and measured in particular by Taylor (2004) and the Globalization and World Cities (GaWC) group and network (Daniels, 2004). On the basis of United Nations data, there were 2 megacities in 1950 (New York and Tokyo), 5 in 1980, 20 in 2005. From economics of cities (Huriot and Thisse, 2000; Fujita and Thisse, 2002) it can be expected that city size favors city globalization, all the things being equal (Bourdeau-Lepage and Huriot, 2005). In 2003, the United States have 65 personal computers per 100 inhabitants. Developing world have less than one (International Communication Union). The number of telephones is less in whole Africa than in Manhattan (Wackermann, 2000). Bairoch (1988) emphasizes the "urban inflation" of the Third World. Sassen (1991, 2000) stresses the emergence and growing domination of global cities. It makes possible the participation to strategic economic decisions, and permits a better economic integration (Bourdeau-Lepage, 2005). City globalization may well be a factor of growth of a new kind of inequalities (Sassen, 2000).

Makinde (2012) takes a look at urbanization, housing and environment in Africa megacities; it enumerates the problems caused by the continued influx of migrant into cities, and state the government, private and public organization effort in solving these challenges. Lagos has grown from 300,000 in 1950 to an estimated 15 million by 2007, and the Nigerian government estimates that city will have expanded to 25 million residents by 2015 (UN Commission on Population and Development). Cairo, Calcutta, Mexico City, Buenos Aires, So Paula, and Seoul, among others, are already experiencing such processes (Renaud, 1981; Richardson, 1989).

Kennedy, et. al (2015) express that collectively the resource flows through megacities are largely consistent with scaling laws established in the emerging science of cities. Correlations are established for electricity consumption, heating and industrial fuel use, ground transportation energy use, water consumption, waste generation, and steel production in terms of heating-degree-days, urban form, economic activity, and population growth.

Kasarda, and Rondinelli (1990) summarizes population grew rapidly in cities and towns in industrial countries during the late nineteenth and early twentieth centuries, and a similar "urban revolution" is now taking place in much of the developing world. Likewise, Sao Paulo, a city of just 2.8 million in 1950, is projected to reach nearly 24 million by the year 2000 (United Nations 1989). The number of million-plus cities in the Third World is expected to reach 279 by the year 2000, 374 a decade later, and just under 500 in 2025 (Dogan and Kasarda 1988). In 1950, Buenos Aires was the only city in a developing country to have 5 million residents. The 30 cities projected to have more than 5 million residents in the year 2000 will house a total of over 330 million (United Nations 1989). As in Western industrial countries, economic growth and social progress in developing nations will depend increasingly on the efficiency with which enterprises in cities transform resources in new ways to replace imports and generate exports over long periods of time (Jacobs 1984). But it is equally clear that as mega-cities grow, physical disamenities of dense urban living, ineffective environmental protection policies, and adverse patterns of industrial and commercial development are manifesting themselves in increasing air and water pollution, depletion of natural resources, and deterioration in the quality of urban life (Brown and Jacobson 1987). The environmental problems threaten to undermine the capacity of cities to support the productive activities on which their populations depend for employment and improved standards of living (Rondinelli 1988).

These cities are often centres of innovation and innovation diffusion, and they facilitate countrywide modernization (Rondinelli 1983). Sao Paulo, with about 10 percent of Brazil's population, contributes over 40 percent of industrial value added and one-quarter of net national product (UNCHS 1985). Cities in less developed countries are contributing a disproportionately large percentage of GNP (ADB 1986). Dhaka accounts for nearly all of the country's employment in rubber products, 97 percent of the jobs in the furniture industry, 84 percent in footwear production, 82 percent in leather goods, and more than half in machinery production and textiles (United Nations 1987). Mega-cities also transform, distribute, and consume large amounts of agricultural products and goods produced in rural areas, thus providing much-needed markets for the rural sector (Rondinelli 1987). More than 9,000 tons of vegetables are brought to Shanghai daily from surrounding rural production areas in China for sale in the city's markets; fruit supplies to the city have increased from about 148,000 tons in 1980 to more than 360,000 tons in 1986 (MacKenzie 1987). More than 8,000 tons of fruits and vegetables are sold every day in the principal wholesale market alone in Mexico City (Melendez 1987). Unprocessed wastes of urban industries are increasing toxicity, and ambient temperatures of rivers and sea water are reducing oxygen solubility (Manshard and Ruddle 1981). In Colombia, the Tujuelito River flowing through the southern section of Bogota is polluted with industrial discharges of heavy metal ions (Castaneda 1989). In Kanpur, only three of the city's 647 factories have treatment plants (CSE 1989), causing huge fish kills and severely reducing the average catch. The uncontrolled dumping of untreated wastes into rivers, canals, and bays in Manila has created since 1988 (Jiminez and Velasquez 1989). The impact or environmental damage on the national economy is estimated to represent a loss of 5 to 7 percent of the national income" (Gruber 1989). In Poland, it is estimated that 95 percent of the river water is now unfit for drinking, and three quarters of the drinking water does not meet official health standards (Diehl 1989). More than 73 percent of the valley's forests have been cut, and 71 percent of the soil has eroded (Schteingart 1989). Because of the overuse of ground water in Bangkok, much of the land in the southern and eastern parts of the city is sinking by 5-10 centimeters a year (United Nations 1987c). The operation of foundries, metal processing, paint manufacturing, cement production, and smelting operations in and around the Mexico City metropolitan area generate high levels of particulate matter (Schteingart 1989; USAID 1979). Vehicle emissions and stationary fuel combustion (Thomas 1987). Less than one-third of the urban population in Indonesia has access to safe disposal of human waste (World Bank 1984). About 80 percent of the nearly 2,500 metric tons of solid waste generated every day in Bangkok is collected (United Nations 1987c). Bogota, Columbia, generates more than 1.5 million tons of garbage annually (Castaneda 1989). In Manila, more than 2,000 cubic meters of garbage are thrown into waterways every day (Jiminez and Velasquez 1989). Many cities in less developed countries are now spending over 30 percent of their budgets on waste collection and disposal, and few will be able to cope with emerging problems through public-sector financing alone (Gunnerson and Jones 1983). Preliminary evidence indicates that recycling can conserve energy that would normally be used in incinerating fertilizers that further pollute water resources, generate employment and opportunities for small-scale enterprise, reduce dependence on foreign imports of metals and inorganic material, and conserve water resources (Rondinelli 1988). Plants in Sweden, the Netherlands, Germany, and England also produce significant amounts of refuse-derived fuels (Abert 1986). Recycling also accounted for more than 25 percent of national glass consumption in Austria, Belgium, France, Germany, and Switzerland (FEVE 1985). In a number of developing countries, private firms are used to supplement local government services (Lewis and Miller 1986). The collection and disposal of solid waste in urban areas in less developed countries provide jobs for large numbers of the poor who are employed by municipal governments or private contractors or who work on their own as scavengers (Cointreau et al. 1984). Compost for fertilizer is now being made in a plant in Port-au-Prince, Haiti, by mixing preheated shredded refuse and pit latrine waste (Obeng and Wright 1987). Studies of 33 cities in India indicate that more than one-third of the wastes collected in nearly all of the urban areas is being composted and sold (Cointreau 1982).

Chow, Watson, Shah, Klang, Loh, Lev-On, Lents, Mollna, Mollna (2004) examined nine large metropolitan areas to identify similarities and differences that affect pollution and its adverse effects. They found that cities in developing nations have higher pollution levels than cities in wealthier nations.

Bourdeau-Lepage, and Jean-Marie (2007) focuses on cities with more than 5 million inhabitants, which are called "megacities", given that this term has no universal meaning. The number of cities of more than 10 million inhabitants has grown from 2 in 1950 to 20 in 2005 (UN, 2004). Institutions is the second key concept of this paper. They can be defined as "the rules of the game in a society, or the humanly devised constraints that shape human interaction" (North, 1990). They aim at facilitating exchanges and cooperation, whatever their nature, provided that their consequences are judged positive by the society (North, 1990). Yet, "the inability of societies to develop effective, low-cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment of the Third World" (North, 1990). Keivani et al. (2003) is a good illustration of these relations between coordination, interactions and institutions. Corruption is defined as "a crime perpetrated by officials who misuse public office for private gain, and, at an aggregate scale, denies citizens their right to self-determination" (United Nations Center for Human Settlement, 2001). It discourages entrepreneurship, disfavors foreign investments and international interactions, and makes global coordination more difficult (Bourdeau-Lepage and Kolarova, 2005). Corruption is widespread in developing countries (Transparency International, 2005). It is negatively correlated with the degree of urbanization of countries (United Nations Center for Human Settlement, 2001, from a sample of 85 countries). It could be because "urbanized societies require more accountability and more transparency of public officials" (UNCHS, 2001). In the informal society of a number of LDCs, exclusion is not only destructive but also creative (Baron, 1995; Huriot, 1997). Formal employees may have a second informal job, the informal production is sold to formal workers, and informal workers spend their income on formal markets (Daniels, 2004). In addition, the administrative sector has generally overdeveloped in most LDCs since decolonization, and low order services are overrepresented in the private formal tertiary sector (Wackermann, 2000). Bairoch (1988) emphasizes the "urban inflation" of the "Third World". Sassen (1991, 2000) stresses the emergence and growing domination of global cities. It makes possible the participation to strategic economic decisions, and permits a better economic integration (Bourdeau-Lepage, 2005). However, city globalization may well be a factor of growth of a new kind of inequalities, not only between cities, but between nations, and can contribute to the formation of a "new geography of centrality and marginality" (Sassen, 2000). A number of studies show that global cities differ from one region to the other in the world, in terms of functional specialization (Taylor, 2003). Of the 20 present largest megacities, Mexico City, Sao Paulo, Mumbai, Jakarta and Cairo show some signs of globalization (Gugler, 2004). Even in Africa, some cities are going to gain an international dimension (Van der Merwe, 2003). The Human Development Report 2005 (UNDP, 2005) defines the HDI as “a summary measure of human development.”

Borsdorf, and Coy (2009) refers to how megacities of the South are affected in their development by global changes in natural and social systems. To a certain degree megacities are vulnerable to climate change, which may limit their provision with drinking water and energy and may increase problems of air and water pollution, but also may affect them by morpho dynamics, heavy precipitations and inundations.

Mavropoulos present the challenge of waste management for the emerging megacities of the developing world and transition countries and to outline major issues that have to be further elaborated in order to create sustainable patterns in waste management.

Moran, Kanemoto, Jiborn, Wood, and Seto (2018) conclude that concerted action by a limited number of local governments can have a disproportionate impact on global emissions. The IPCC 5th Assessment Report concluded that urban areas generate the majority of carbon emissions from final energy use (Creutzig et al 2015, IPCC 2014). However, while reporting standards are emerging (Carbon Disclosure Project 2016) for conducting such assessments, individual city inventories are generally neither comparable nor comprehensive (Fong et al 2016, Kennedy et al 2010, Pichler et al 2017). Bottom-up inventories often use different methods, different study boundaries, and are based on different kinds of data, depending on local data availability (Lombardi et al 2017). One study by (Min and Rao 2017) suggests that such errors lead to an uncertainty of ±20% for household footprints.

Comment (2017) claims that transitions from rural to urban living are often prompted by promises of increased economic opportunities and cheaper health care, education, and transportation. By 2030, two-thirds of the world’s population will reside in urban areas and there will be 41 megacities, of which over 80% will be in low-income and middle-income countries. Air pollution also has a substantial effect on the wellbeing of people worldwide. This pollution can consist of Sulphur dioxide, ozone, nitrogen dioxide. Kötter, T. (2004) certain popular global insights. According to The State of World Population 2001, an actual report from the United Nations Population Fund, roughly 2.8 billion people live already in cities and by 2015, that number will have risen to 3.9 billion. The total population is increasing by 280000 people per day. Urbanization has come to stand still and they can notice a process of deurbanization and sub-urbanization caused by a high rate of motorization combined with prosperity and the development of traffic and communication infrastructure. Roughly a quarter of the population of the developing countries are living in situations of absolute poverty on less than one dollar per day (UNDP 1997).

Kutzbach (2010) acclaims that income alone cannot explain motorization because countries with similar income levels often have widely varying levels of car use. As a general rule, rising incomes lead to increased car use and worse traffic congestion. The streets of cities in developing countries serve multiple travel modes, reflecting the wide range of incomes among commuters and the variety of trip lengths and purposes. Comparing the IRF’s data on passenger cars per 1,000 people with the World Bank’s data on per-capita income shows that rising incomes are, unsurprisingly, associated with increasing car ownership.

Marlier, Jina, Kinney, and DeFries (2016) assess recent findings on the impacts of extreme air pollution, which they define as concentrations exceeding international guidelines. They then emphasize important new methods for monitoring air pollution exposure, such as satellite-based estimates, and suggest future needs, including a more comprehensive understanding of the health and economic impacts. In addition, Farmer et al. reviewed how early-life exposure can affect cardiopulmonary health later in life. Much of this research is drawn from empirical studies in developed countries, and estimated costs are substantial (Chang et al.). The impacts on cognition, both contemporaneously and in utero, suggest that human capital, an important factor of economic growth and well-being, is being negatively affected by pollution exposure (Graff Zivin and Neidell).

Zheng, Huang, Xu, Li, and Jiao (2023) investigate how urban land density and nighttime light intensity decline with the distance to center using the inverse-S function. The impervious surface acquired from remotely sensed data is the direct representation of urban expansion (Patino, Duque, 2013; Van de Voorde et al., 2011), but it neglects the urban dynamics of socioeconomic activities. The nighttime light satellite imagery can inspect the intensity and spatial disparity of urban dynamics (Bagan, Yamagata, 2015; Li, et al., 2015) and estimate energy consumption (Bennett, Smith, 2017; Letu et al., 2010; Levin et al., 2020). As an appropriate proxy to measure the intensity of socioeconomic activities, nighttime light is a com prehensive indicator that conveys information from spatial distribution, economy, and other factors influencing urban development (Bennett, Smith, 2017; Mård et al., 2018). Nighttime light shows a solid ability to assess urban development in terms of both spatial and socioeconomic status (Elvidge et al., 2023) and can provide insights into the identification of urban structure and the state of urban development (Kyba et al., 2017; McCallum et al., 2022; Ren et al., 2022). The Visible Infrared Imaging Radiometer Suite (VIIRS) nighttime light imagery acquired by the Suomi National Polar-orbiting Partnership Satellite is widely used for regional economy and urban studies (Li et al., 2022b).

Desmet, and Rossi-Hansberg (2014) briefly sketch the main forces in that model and later discuss which data are needed for policy analysis. In Desmet and Rossi-Hansberg's (2012) framework, a country has a given number of cities. <u>Many countries, like China, have internal migration restrictions</u>. When calculating reallocation following the methodology of Davis and Haltiwanger (1992), they find reallocations of 37 percent when eliminating differences in efficiency, 20 percent when eliminating differences in amenities, and 44 percent when eliminating differences. In China, Shenzhen would grow to a population of 27 million, and Guangzhou would increase its population 64 percent. This finding is in line with Au and Henderson (2006), who argue that China's megacities are too small.

Pojani, and Stead (2015) argue that a focus on smaller and medium-sized cities is crucial to achieving substantial progress towards more sustainable urban development. <u>These lessons are certainly not always identical to those for megacities in the global south</u>. In the developing world, Beijing, Mexico City, Bombay, and Cairo have metro or suburban rail systems. Idowu, and Zhou (2023) examines the correlation between urban expansion patterns and increased flood hazards. They also found that all these cities have all experienced devastating floods at least twice, with Jakarta, Seoul, Sao Paulo, Lagos, and London having a flood event that occurred during the compilation of this work (2022) and Los Angeles in 2023. In our comparison of the Dartmouth Flood Observatory (DFO) to the Think Hazard (TH) flood-hazard classes, they found that cities such as Sao Paulo, Los Angeles, Moscow, and London having a low flood hazard.

Evans (2015) summarizes that urbanization is seen by many scholars as a solution to alleviating long-term poverty and political instability in regions from Asia through Latin America to some parts of the Middle East and Africa. As Richard Dobbs has noted, “the new era of cities will actually be the era of Asian cities.” Decker, Elliott, and Smith (2002) express that climatic, demographic, and economic data show no patterns across cities, save that wealthier cities have lower growth rates. The flows of water, fuels, construction materials, and food are examined where data are available. Kötter, and Friesecke identifies the risks of the ongoing form of urbanization. Managing urban growth has become one of the most important challenges of the 21st century (cf. Cohen 2006, p. 78).

India currently has **six megacities**, which are cities with a population of over 10 million people. These megacities are Delhi, Mumbai, Bengaluru, Chennai, Kolkata, Hyderabad. The UN's World Cities Report predicts that two more cities will be added to this list by 2030.

Megacities in India

The increasing compaction of people in cities resulting in megacities, which, per the United Nations, is typically an urban agglomeration of 10 million or more is a global phenomenon. By that definition, India is home to six megacities: Delhi; Mumbai; Bengaluru; Chennai; Kolkata, and Hyderabad (Rathore).

The dichotomy of Indian megacities

Post-independence, the First and the Second Five Year Plans (1951-61) focused on providing affordable housing to low-income groups, workers, and government employees. In the last two decades, policies such as PMAY-U, AMRUT 2.0, and Smart Cities Mission have been initiated to rejuvenate cities. High-rise buildings adorn the cityscapes, which are home not only to the richest people in India (Rathore).

Building sustainable cities

India’s megacities are faced with mammoth challenges such as toxic air, a decrease in forest cover, depletion of water tables, and poor waste management. India has pledged to sustainable development goals and aims to make its cities inclusive, safe, resilient, and sustainable by 2030. This requires climate-proofing the cities and investment in sustainable energy and infrastructure. As of 2024, India issued green bonds worth over 15 billion U.S. dollars. Climate change is expected to induce greater rural-to-urban migration because of droughts, rise in sea levels, and cyclones. The United Nations estimate that by 2047, half of India’s population will be living in urban areas. This necessitates a paradigm shift in urban planning, spatial, social, and economic inclusion, and infrastructure and municipal services investments (Rathore).

Mega-cities, Mega-projects, and Mega-slums: Exploring Urbanization in India

As a result of the nation’s ardent aspirations for growth and development, the social, economic, and physical landscape of India has transformed. A significant portion of the region’s population is of working age and comprises a massive market size, making India a land of opportunity especially in the eyes of foreign investors. It describes the energy of aspiration and ambition while also addressing the stark contractions and pressing challenges that demand thoughtful solutions and integrated planning (Gattupalli, 2024).

Mega-projects

Alongside the establishment of mega-cities, the government has initiated multiple large-scale infrastructure projects to address the country's development goals and urbanization needs. These mega-projects span various sectors. Mega-projects are motivated by a reform-oriented lens that views insufficient infrastructure as the main barrier to economic expansion. The displacement of communities, particularly those from lower-income groups, can aggravate urban inequality and contribute to the growth of slums. The degree to which these projects meet the demands of all city inhabitants and blend in with the current urban fabric will determine their success (Gattupalli, 2024).

Balancing Ambition and Equity

India treads a tricky path, striving for a balance between infrastructural ambition and equitable urban living. The way forward calls for harmony – a multifaceted approach that caters to the complexities of urban development while ensuring equal distribution of the benefits of growth. One such approach may be to adopt a dispersed urbanization model where emphasis is placed on Tier 2 and Tier 3 cities. A greater focus on affordable housing policies and measures along with a reconsideration of slum rehabilitation strategies is crucial. Such measures must acknowledge informal settlements as integral parts of the urban fabric rather than problems to be eliminated. Bringing a commitment to inclusivity into the vision of ambition and prosperity will allow the country to develop cities and projects that are not just mega in scale but in impact (Gattupalli, 2024).

SUSTAINABLE DEVELOPMENT GOALS

von Foerster, H. (1972) opined "Corruption of our society", "psychological disturbances", "cultural erosion", the "breakdown of communication", and all the other of these "crises" of today are our problems as well as his. They apply the competences gained in the hard sciences to the solution of the hard problems in the soft sciences.

Chen, R., Zhang, R., Han, H. (2021) obtained 9848 records of literature information from the database of Web of Science, a bibliometric analysis was implemented to judge the knowledge domain structure and evolution of frontiers in CF research by using the Cite Space to make up for the lack of previous reviews. The results showed that the CF research was concentrated in the fields of Engineering, Environmental sciences ecology, Science technology other topics, Energy fuels, Computer science and Business economics, and there is a significant cooperative relationship between researchers, especially those with a high volume of publications (Wiedmann and Minx, 2008). Global Footprint Network (GFN) indicates it as a synonym for the demand on "CO2 land" or biomass fixation that is used to offset GE from fossil fuel combustion through photosynthesis (Galli et al., 2014). Wiedmann and Minx (2008) suggested the scientific definition "a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product", and other GHG are usually added to the measurement range in subsequent research practices (Pathak et al., 2010; O'Brien et al., 2014; Yan et al., 2015; Cheng et al., 2015; Rebolledo-Leiva et al., 2017; Bartocci et al., 2019). Simultaneously, with the aims of holding global warming to well below 2 degrees Celsius and to "pursue efforts" to limit it to 1.5 degrees Celsius proposed by the Paris climate agreement (Rogelj et al., 2016).

The effective planning of GE reduction action policies always come from the function of identifying emission hot spots in product supply chain by CF, taking food system as an example, meat and dairy products were the most GHG-intensive types of food (Garnett, 2011), where key emission sources mainly included intestinal fermentation and fecal management in its production process (IPCC, 2006; Rotz et al., 2010; O'Brien et al., 2014), and beef production typically had the highest global warming potential (GWP) (de Vries and de Boer, 2010; Notarnicola et al., 2017). Among the crop production systems, rice cultivation contributed the most to methane emissions (ME) (Pathak et al., 2010), accounting for 0.69 of the total CFs of flooded paddy rice in China on average (Cheng et al., 2015), and the utilization of fertilizer and energy was key emission sources in agricultural production stage (Pathak et al., 2010; Yan et al., 2015; Cheng et al., 2015). From the perspective of consumption-based CF, globally, there were over 5.3 Gt of CO2 embodied in trade among 87 countries for the year 2001 (Peters and Hertwich, 2008), which had increased to 7.8 Gt CO2 covering 113 countries in 2008 (Peters et al., 2011). Obviously, CF stands for a professional term was widely used in the public domain to cope with the threat posed by climate change (Weidema et al., 2008; Wiedmann and Minx, 2008; Matthews et al., 2008). A research front is defined as an emergent and transient grouping of concepts and under lying research issues, and an evolving network of scientific publications cited by it constitutes the intellectual bases, demonstrating its citation and co-citation footprint in the scientific literature (Chen, 2006). Cite Space is a bibliometric analysis tool they borrowed and applied to this study to explore the above information (Chen, 2016). The term "carbon footprint" in the WoSCC database emerged in 2006, and the four literature records published were a National Footprint Accounts (NFA) data set containing CF, two invention patents for CE reduction, and a journal paper of the CF estimation of student halls of residence in the University of Strathclyde (Bezyrtzi et al., 2006). The number of literatures published in five continents was 2771 (Europe), 2114 (North America), 1821 (Asia), 496 (Oceania) and 147 (South America), and the cooperation frequency was 2456 (Europe), 1703 (North America), 1313 (Asia), 436 (Oceania) and 134 (South America), respectively. In the intellectual base of C02, Wiedmann and Minx (2008) suggested a scientific definition based on commonly accepted accounting principles and modeling approaches on CF (Lenzen et al., 2007). United National Framework Convention of Climate Change has been critiqued for not including international transportation and potentially causing carbon leakage, and the emissions embodied in the trade may have a significant impact on participation in and effectiveness of global climate policies such as the Kyoto Protocol (Peters and Hertwich, 2008). Although which type of the model is most suitable for CF accounting depends on the research purpose of the particular application, the MRIO models are particularly appropriate to estimate the CF of production, consumption, imports and exports (Wiedmann et al., 2007) significantly to environmental problems such as ecosystem pollution, global warming by GHG emission and biodiversity loss (Opio et al., 2012). Flysj¨ o et al. (2011) analyzed the 1 kg of energy corrected milk CF at the farm gate for an outdoor pasture grazing system in New Zealand was 1 kg CO2 eq and a mainly indoor housing system with pronounced use of concentrate feed in Sweden (SE) was 1.16 kg CO2 eq based on the LCA methods. The early CF accounting specifications focused only on direct GE or energy emissions, which led to large underestimates of CE for providing products and services (Matthews et al., 2008; Lee et al., 2011). However, scientifically drawing system boundaries is difficult and even suffer from a truncation error (Suh et al., 2004), which is caused by the omission of resource requirements or pollutant releases of higher-order upstream stages of the production process (Lenzen et al., 2000). For this reason, a hybrid evaluation method combining process analysis with input-output analysis was proposed as an effective solution (Lenzen et al., 2000; Suh et al., 2004). Milk production CF in organic farms showed better environmental performance than for conventional farms (Thomassen et al., 2008). C5 and C1 were closely linked by two key articles Thomassen et al. (2008) and de Vries and de Boer (2010), because the livestock sector is an important determinant of human health and diet (de Vries and de Boer, 2010). Pelletier et al. (2010) held that impacts per live-weight kg were higher than pasture-finished for the cumulative energy use, ecological foot print, greenhouse gas emissions and eutrophying emissions at the assuming equilibrium conditions in soil organic carbon fluxes across systems. Nevertheless, the environmental cost will not keep within limits the increasing demand for livestock products, hence these livestock food chains are bound to major contributors of GE (Gerber et al., 2013), which was emphasized by IPCC (2006). C6 was closely connected to C0 through Peters and Hertwich (2008) and Minx et al. (2009), how to standardize the application of MRIO model and bring together the rigorous economic modeling and the practice of GHG accounting at various levels were discussed in this intellectual base (Wiedmann 2009). Minx et al. (2009) and their research team took the UK as example highlighted the multiple uses of generalized multi-regional input-output models for carbon footprint in seven areas of national emissions inventories and trade, emission drivers, economic sectors, supply chains, etc. Meanwhile, uncertainty analysis and a time series of balanced input-output tables were implemented for this case by Lenzen et al. (2010) and Wiedmann et al. (2010). Druckman and Jackson (2009) found CE of households in the UK were 15% above 1990 levels in 2004 based around a quasi-MRIO model, and recreation and leisure accounted for over one- quarter of total emissions. A fully coupled MRIO model based on global economic data in 2004 was used in consumption-based accounting of CE, the result showed 23% of global emissions were traded internationally in 2004 (Davis and Caldeira, 2010). C10 is the growth of the C1 intellectual base that focusing on regional differences or comparison in milk production systems, through Rotz et al. (2010) and Flysj¨ o et al. (2011). From the perspective of historical practice, the CF per billion kilograms of milk produced in modern US dairy production in 2007 was 37% of equivalent milk production in 1944 (Capper et al., 2009). O'Brien et al. (2014) indicated that if GE was only attributed to milk, CF from the Irish grass-based system was 5% lower than the UK confinement system. Furthermore, Eastern Canada was taken as a typical CF research case of milk products in extensive citing literature because most dairying occurs in this area in Canada (McGeough et al., 2012). Choosing a more environmentally-friendly livestock product in a diet can mitigate the environmental impact (de Vries and de Boer, 2010). The impact of human food consumption on the environment was extensively discussed in C2, which was connected with C5 by de Vries and de Boer (2010) and Roos et al. (2013). A consumption-oriented life cycle perspective favors understanding the environmental implications of dietary choices and resulting consumption patterns (Heller et al., 2013), Notarnicola et al. (2017) indicated the meat products and dairy products were with the highest environmental burden after the assessed environmental impact of the average food consumption of European citizens. An estimated 80% increase in global agricultural GE if these diets higher in refined sugars, refined fats and meats would be not controlled (Tilman and Clark, 2014). The dietary change could reduce 50% GE and land use demand in areas with an affluent diet (Hallstrom et al., 2015). Therefore, shifting diets and reducing waste, especially, away from diets rich in GHG-intensive meat and dairy foods is a task of top priority (Garnett, 2011; Foley et al., 2011). Whether the environmental burden of food consumption could be represented by the CF indicator is queried because some environmental impacts do not change with climate change, especially those related to emissions of toxic substances (Laurent et al., 2012). C7 was linked with C6 through Davis and Caldeira (2010) and Peters et al. (2011). Although international trade is a significant factor in explaining not only the changes in regional CE (Peters et al., 2011) but also the various environmental pressures caused by a nation's consumption of goods and services (Steen-Olsen et al., 2012), the importance of trade chains as a driver of threats to species is poorly understood (Lenzen et al., 2012a,b) and even obscured the causal relationships in biodiversity loss (Weinzettel et al., 2013). This package of footprint indicators is integrated into the framework of sustainability measurement (Cucek et al., 2012), which is defined as "Footprint Family" by Galli et al. (2012) and Fang et al. (2014). Steen-Olsen et al. (2012) used the MRIO model to quantify the total environmental pressures characterized by footprint family indicators found that an average EU citizen in 2004 consumed 13.3 t CO 32 eq, 2.53 gha and 179 m activities of blue water in their consumption Case Studies of hybrid LCA application constituted the intellectual base of C11, which related to C0 through Wiedmann et al. (2007) and Miller and Blair (2009). Lenzen et al. (2012a, b) applied the environmentally extended MRIO tables in LCA, the high country and sector detail drastically improved the resolution of LCA. Weber and Matthews (2008) indicated that transportation represented only 11% of life-cycle GE associated with food production in the United States and final delivery from producer to retail contributed only 4% through the method utilized of hybrid LCA. 19–29% of global anthropogenic GE came from the food systems in 2008, in which the agricultural production contributed 80–86% (Vermeulen et al., 2012). Clune et al. (2017) reviewed 369 published studies with the food categories of fresh vegetables, fresh fruits, staples, dairy, non-ruminant livestock and ruminant livestock found that meat from ruminants having the highest impact on GWP but grains, fruit and vegetables having the lowest. GE from 24 Indian food items showed that ME mostly came from the animal food products and rice cultivation, and food products from crops accounted for the most NE (Pathak et al., 2010). Climate change, in turn, poses a threat to food production in agricultural yields and earnings, food quality, and, notably, food safety (Vermeulen et al., 2012). Historical statistical studies in CF of crop production from China provide the intellectual bases for this topic from Cheng et al. (2011), Yan et al. (2015) and Cheng et al. (2015). Lenzen et al. (2012a, b) and Lenzen et al. (2013), who is committed to compiling large-scale global MRIO tables that represent all countries at a detailed sectoral level and provide information on data reliability (Tukker et al., 2016). Similarly, Wood et al. (2015) focused on environmental activities and constructed a global MRIO database (EXIOBASE), which allowed for more details of consumption footprints. Moreover, the construction of the World Input-Output Tables (WIOTs) was described by Dietzenbacher et al. (2013). Due to the convenience of accessing these input–output databases, using a "footprint" perspective to capture the global dimension of resources and their impacts is para mount in understanding the sustainability, efficiency (Hoekstra and Wiedmann, 2014; Tukker et al., 2016; Wiedmann et al., 2015). Therefore, these provide an opportunity to estimate the maximum sustainable footprint levels and improve the efficiency of natural resource utilization, ensuring that the anthropogenic perturbation levels of the earth system are within the proposed Planetary Boundary (Steffen et al., 2015). The CF of household consumption and its drivers were discussed in C9, in which the intellectual base was linked with C6 through Davis and Caldeira (2010) and Minx et al. (2013). Minx et al. (2013) used a hybrid method to estimate the human settlements CF in the UK found that 90% of the areas were net importers of CE. In contrast, Ivanova et al. (2017) calculated the CF associated with household consumption for 177 regions in 27 EU countries and indicated income was the most important driver for a region's CF. Besides, significant differences were in the size and composition of CF between geographic regions when the typical U.S. households CF was calculated in 28 cities for 6 household sizes and 12 income brackets by Jones and Kammen (2011).

Tamburino, and Giangiacomo (2021) highlights that the EF neglects crucial aspects of environmental sustainability, such as water consumption, soil health, and biodiversity losses (Blomqvist et al., 2013; Giampietro and Saltelli, 2014). From this point of view, it identifies a necessary condition for sustainability although not a sufficient one, a point acknowledged by Wackernagel et al. (2018) himself. Even considering these caveats, a recent review recognizes significant merits to the EF method for both scientific research and policy making, especially when used in conjunction with other indicators and sustainability criteria (Zhang et al., 2017). For instance, India has a per capita eco-deficit of only 0.8 gha/cap., while its total deficit is about 10.23 × 10 8 gha, namely over 175% of the country's biocapacity (Global Footprint Network, 2021). The population bio density (PB) is defined as the ratio between the population (P) and biocapacity (BC) of a given area: PB =P/BC (1) where the biocapacity is measured in global hectares (gha) and follows the definition given by the Global Footprint Network (Global Footprint Network, 2020). Nevertheless, EF pc is computed starting from consumption data, which represent a crucial component of wellbeing, at least for low- and middle-income levels (Pretty, 2013), and strongly correlates with several income and development indicators, most notably with the per capita Gross Domestic Product (GDP) (r = 0.74) and the Human Development Index (HDI) (r = 0.74). The group also includes countries, such Australia and Brazil, that exert strong pressures on freshwater resources (Lam et al., 2016) or have high deforestation rates (Seymour and Harris, 2019). As in the previous case, this group also includes countries with high deforestation rates, such as the Democratic Republic of the Congo (Tyukavina et al., 2018). The world as a whole has a negative eco-balance (EB= 0.73) and a per capita footprint above the threshold τ (EF pc=2.78 gha). An important question is whether changes in consumption patterns and technological improvements enable a sufficient reduction of environmental impact clearly avoiding coercion and learning from existing examples of successful voluntary family planning programs (Robinson and Ross, 2007; Wolf et al., 2021; O'Sullivan, 2018). This important question cannot be answered by theoretical reasoning alone and alternative options need to be systematically evaluated on the light of reliable criteria and indicators (Bell and Morse, 2019; Bravo, 2014). One of the most widely used sustainability indicator is the ecological footprint (EF) (Kitzes et al., 2009; Zhang et al., 2017). The EF was originally developed in the 1990s by Mathis Wackernagel and colleagues as an estimate of people's consumption of ecological capital (Wackernagel and Rees, 1996; Wackernagel et al., 1999). Although not exempt from criticisms (e.g., Giampietro and Saltelli, 2014; Kitzes et al., 2009), the EF presents several advantages in comparison with other environmental indicators (Cucek et al., 2012; Hoekstra and Wiedmann, 2014; Wiedmann and Barrett, 2010). First, it is based on consumption, hence internalizing any eventual displacement of environmental impact outside national borders (Andersson and Lindroth, 2001; Grazi et al., 2007; Peters et al., 2011; Hoekstra and Wiedmann, 2014). Second, it is accounted using "global hectares" (gha) units of surface with world average bio-productivity (Global Footprint Network, 2020). This relates the EF to the concept of planetary boundaries (Downing et al., 2020; Wackernagel et al., 2018) and allows to directly estimate the quota of biocapacity consumed by human activities in a given period of time (Hoekstra and Wiedmann, 2014). Earlier critics, mainly focusing on conceptual and measurement issues (see Kitzes et al., 2009).

Bennich, Weitz, and Carlsen (2020) aims to decipher the literature on SDG interactions by providing an overview of the current research, based on a sample of 70 peer-reviewed articles. Research gaps are identified, where perspectives largely missing include policy innovation, and integrated monitoring and evaluation. The 2030 Agenda was adopted by the United Nations General Assembly in September 2015, presenting an ambitious vision of transformative change towards reaching a more sustainable future by the year 2030 (UN, 2015). The 2030 Agenda includes 17 overarching sustainable development goals, 169 related targets and more than 230 indicators for monitoring their progress. It also does not provide guidance on how to identify or address potential spill-over effects and cross-scale interactions (Elder et al., 2016; Nilsson et al., 2018). Breuer et al. (2019) review existing frameworks developed to conceptualize SDG interactions. Most of the literature included in the review was collected in a nearly stage of SDG implementation, encompassing in total nine studies, all published in 2017 (Breuer et al., 2019). Allen et al. (2018a) review academic and grey literature on SDG implementation, and contrast it with national experiences of the implementation process. The authors stress that a lack of systems thinking and integrated assessments may hinder the effective implementation of the SDGs (Allen et al., 2018a). Here they use a modularity-based approach to clustering (Newman and Girvan, 2004; Newman, 2006). In bibliometric research a combination of mapping and clustering techniques is often used in order to study and visualize (Waltman et al., 2010). It has been demonstrated how systems analyses allow policy-makers to negotiate trade-offs and exploit synergies as they formulate SDG strategies, supporting the identification of coherent policy (Obersteiner et al., 2016). Dynamic simulation models have been put forward as facilitators of a shift to discussions on development that is grounded in systems thinking (Collste et al., 2017), and mapping of SDG interactions has been suggested as a way to help policy-makers and researchers find development pathways that minimize negative interactions while enhancing positive ones (Nilsson et al., 2018). However, enhanced governance and coordination capacity are required (Yillia, 2016; Elder et al., 2016). Along the same lines, it has been emphasized that a shift to integrated approaches re quires pro-active engagement and enhanced coordination across government departments and scales (McCollum et al., 2018). They are yet included in this category as their overarching objective is to support more coherent policy (Maes et al. (2019), Blanchard et al. (2017) and Chakraborty et al. (2018)). It has been suggested that deeper changes in existing strategies are needed to make the trade-offs between SDGs structurally non-obstructive (Pradhan et al., 2017), and that new business models based on systems thinking are needed, integrating environmental, social, and economic interests (Keesstra et al., 2018). Other studies assess alternative pathways for SDG achievement focused on lifestyle changes, decentralized governance and technology (Moyer and Bohl, 2019), or stress that rebounds across resources need to be addressed to ensure effective design of emerging policy paradigms such as the SDGs (Font Vivanco et al.,2018). Studies have shown that the geographical level matters significantly in assessments of SDG achievement (Moyer and Bohl, 2019), and that realizing co-benefits among the SDGs is dependent on the context specific social-ecological dynamics and policy priorities (Singh et al., 2018). As concluded by McCollum et al. (2018) in the case of energy, knowledge gaps remain about how interactions play out in different contexts, and Nilsson et al. (2016) even warn against relying on generalized knowledge on SDG interactions because of how these interactions are influenced by differences in geography, governance and technology. SDG interactions have been explored in, for example, coastal Bangladesh (Hutton et al., 2018), Sweden (Weitz et al., 2017), in a number of countries in the Arab region (Allen et al., 2017), and at a sectorial level in Uruguay (Kanter et al., 2016). There are also examples of studies that contextualize SDG inter actions in relation to other geographies (Hoff, 2018; Liu, 2017). For example, these studies present frameworks developed to guide priority setting (Singh et al., 2018; Weitz et al., 2017; Kumar et al., 2018), rank synergies and trade-offs between SDGs (Pradhan et al., 2017), and inform strategy development (van Vuuren et al., 2015). They call for or present new frameworks for strengthening stakeholder participation, for structuring knowledge for policy-makers (Yillia, 2016; Maes et al., 2019; McCollum et al., 2018), or for improving the uptake of interaction analysis (Weitz et al., 2017). These studies also seek to find new ways to develop and communicate future scenarios (Hutton et al., 2018). Studies have been exploring how accountability regimes and policy integration and coherence are potentially conflicting (Karlsson-Vinkhuyzen et al., 2018), frameworks for developing theory of transformation and indicators that can trace change in complex systems have been proposed and illustrated (Kopainsky et al., 2018), and challenges in measuring progress in integrated targets have been lifted (Le Blanc, 2015).

Robinson, Tewkesbury, Kemp, and Williams (2018) outline a number of key elements to standardize the organisational carbon foot printing process by reconciling and evaluating the methodological steps in six selected internationally reputable guidelines. In proposing this methodology, carbon foot printing is made more applicable to higher education institutions and the practical issues, associated with externally owned data and non-expert staff, are broadly overcome people (United Nations Educational Scientific and Cultural Organization, 2014a, 2014b]). There are estimated to be ca. 17,000 Higher Education Institutions (HEIs) worldwide, distributed among most nations, on every continent (Altbach et al., 2009). The number of students attending university since the year 2000 has grown exponentially; a trend likely to continue under most business-as-usual (BAU) scenarios, which estimate a rise to 262 million by 2025 (Goddard, 2011). Although in developed nations efforts have been made to enact moves towards low-carbon HE systems (Roy et al., 2008), the divide between less economically developed countries (LEDCs) and more economically developed countries (MEDCs) remains considerable (Drori et al., 2014). With more than 318,000 staff and 1.7 million students in 160 institutions, the total economic value per annum equals £39.9 billion (Universities UK, 2015). As a result, HEIs one of the largest occupiers of building space, occupying 27 million mandis responsible for some 10,600 ha of land (HESA, 2014). It is well documented that HEIs are influential players in both local and national policymaking, both informing society through research and educating graduates (Etzkowitz, 1998). In addition, they are also successful incubators for innovation, from which many sustainability initiatives have originated (University of Southampton, 2012), Student Switch off (Jones, 2012). It is widely recognized by university vice chancellors that prioritizing carbon reductions not only yields environmental benefits but also promotes financial savings and increases competition (Epstein and Roy, 2003; Dangelico and Pujari, 2010). Sustainability reporting has been proven to help deliver these benefits (Lozano and Huisingh, 2011) as well as assist university leaders in directing on-campus operations and sustainability projects (Townsend and Barrett, 2015). The benefits manifest in substantial utility cost reductions and an improved international reputation (Barber et al., 2013). Universities are now also finding that by incorporating sustainability education into the curriculum, they can add value to the quality of education students receive, as well as fostering cultural change within the organization (Lozano, 2006; Savageau, 2013). This is important because the future challenge lies in reducing campus emissions whilst simultaneously expanding student numbers, extending their range of activities and remaining commercially competitive (Cronin et al., 2010). The removal of the tuition fee cap in 2010 at the recommendation of Lord Browne did little to dent this trend (Wyness, 2010). The year 2015 saw a record number of students recruited at 532,000, a 3.1% increase on the previous year (Universities and Colleges Admissions Service, 2015). The Higher Education Funding Council for England (HEFCE) published a number of guides in 2012 with the aim of assisting institutions to report and reduce emissions. These focused primarily on direct emissions (HEFCE, 2010, 2012b; Arup et al., 2012). This is often conducted with limited success alongside the unrestricted use of assumptions and caveats to complicate their interpretation (Almeida et al., 2014). The hybridization of input-output analysis and life cycle assessment theories (EEIOA-LCA) (Peters, 2010) are favored here because they generate assessments in greater detail, absent of aggregation errors (Berners-Lee et al., 2011; Ozawa-Meida et al., 2011). Baboulet and Lenzen (2010) used input output analysis informed with readily-available financial expenditure information of an Australian university as a means of assessing supply chain emissions of universities without any addition informational inputs. These can measure total environmental impacts of institution's activities (Mattila et al., 2010). Growing pressure to reduce emissions means that institutions are in danger of falling behind on pledged targets for direct emissions (Robinson et al., 2015). The priorities currently favored by universities in terms of promoting growth and economic fortune can conflict with the importance they assign to carbon management (Lozano, 2013); estate growth disproportionately magnifies scope 3 emissions occurring upstream and downstream of the organisational boundary (Sharp, 2009). The four major functions which universities serve are in education, research, governance (Stephens et al., 2008; Sedlacek, 2013) and enterprise (Rae, 2010). For this reason, a comparison with small towns is often made (Zhang et al., 2011). A rise in internet access means that traditional universities are moving activities online through distance-learning courses (Roy et al., 2008) and Massive Open Online Courses (MOOCs) (Barber et al., 2013). The nature of research programmes has also been seen to have a direct correlation with the energy-intensity of activities (Klein-Banai and Theis, 2013). The reason for examining university carbon management in particular is to continue the debate of the role of HE on sustainability over the 21st century (Barber et al., 2013). Universities play an influential role in providing technical solutions to climate-related issues (Sedlacek, 2013). Their central role in education systems in all societies of the world transcend political regimes and economic systems (Meyer and Schofer, 2007). A qualitative comparative analysis (Gao et al., 2013) is conducted using a selection of frequently used.

Kim (2023) recommends augmenting the indicator framework and integrate indicator development into future negotiations of global goals and targets. On 1 January 2016, the world embarked on a 15-year mission to achieve the United Nations' 2030 Agenda for Sustainable Development. 17 Sustainable Development Goals and their 169 targets have garnered significant public and scholarly attention (Biermann et al., 2022). As of 2023, there are 231 official indicators in use, including some that are controversial such as those based on gross domestic product (United Nations, 2017, 2022). Developed and annually reviewed by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs), these indicators are now widely deployed at all levels of sustainability governance. Some organizations use them to rank the progress countries have made on the SDGs (Shore and Wright, 2015; Schmidt-Traub et al., 2017; Diaz-Sarachaga et al., 2018; Sachs et al., 2021). A key concern when selecting and using indicators is their relevance, or how adequately indicators measure the monitored phenomena of interest (Hak et al., 2016). For example, Kubiszewski et al. (2021: 146) argue that 'most of the current indicators are not necessary' because they are 'unable to measure sustainable development holistically' (Hardi et al., 1997). The process of indicator development is often divorced from policy considerations, with decision-makers first agreeing on goals and targets to be measured (Rametsteiner et al., 2011). In the case of the SDGs, the choice of indicators was delegated to statisticians who met behind closed doors after the goals and targets were established (Kamau et al., 2018; Kapto, 2019; MacFeely, 2020). According to science and technology studies, however, the clear di vision between science and policy does not exist in practice (Watson, 2005). Indicators in particular play a critical role at this science-policy interface, serving as boundary objects that travel back and forth between the two domains (McCool and Stankey, 2004; Turnhout et al., 2007; Turnhout, 2009; Star, 2010). This has been observed in relation to the SDGs where, contrary to the assumption, the selection of indicators was never free from politics (Fukuda-Parr and McNeill, 2019). Statisticians received instructions from their governments, and the interests of powerful governments had a significant influence over the indicator selection process (Kapto, 2019). Any observed statistical regularity will tend to break down when pressure is applied to it for control purposes (Goodhart, 1975). A familiar case in point is measuring the performance of researchers with the h-index (Chapman et al., 2019). The so-called Goodhart's law has become better known in its popularized form put forward by the anthropologist Marilyn Strathern (1997: 308). When such indicators with a narrow scope shape the implementation of the SDGs (Coscieme et al., 2019). This is because, while the wording of the goals and targets are largely complementary (Le Blanc, 2015; Pradhan et al., 2017; Barbier and Burgess, 2019). Yunita et al. (2022: 93) argue that this indicator, when used alone, 'risks neglecting how and whether sustainable development … is (trans)formed'. The more any quantitative social indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor (Campbell, 1979: 85). Numbers are easily manipulated, yet they are powerful (Fukuda-Parr et al., 2014). McNamara believed that quantitative measures such as weapons seized, prisoners taken, sorties flown, and body count could accurately gauge the progress of the war (McNamara and VanDeMark, 1995). Such distorting effects of the numerical approach were observed in the implementation of the MDGs, especially where indicators were poorly chosen (e.g., Fukuda-Parr et al., 2014; Sen and Mukherjee, 2014; Unterhalter, 2014; Yamin and Boulanger, 2014). It has been reported that some local government officials in China manipulate regional GDP numbers to meet national economic growth targets (Lyu et al., 2018). A concrete example of developing alternative indicators is the creation of a new measure that could complement and eventually replace GDP (Kubiszewski et al., 2013; Costanza et al., 2014). This target highlights the need to move beyond indicators such as GDP and to embrace 'well-being', 'happiness', or 'life satisfaction' as key measures (Costanza et al., 2016; Fioramonti et al., 2019). The methodological challenge of measuring such less quantifiable, often subjective, context-specific, and self-reported indicators is real, but there have been successful attempts such as Bhutan's use of gross national happiness (Ura and Galay, 2004; Brooks, 2013). Other examples include the Better Life Index (Mizobuchi, 2014) and Social Progress Index (Porter et al., 2013). Monitoring the SDGs is not just a statistical undertaking; it is an iterative process of dialog at the science-policy interface where questions like what should be measured, why it should be measured, and by whom are continuously debated (Pint´ er et al., 2017; Kanie, 2020).

Berisha, Caprioli, and Cotella (2022) discusses the contents and implications of the SDG11 target 11.a. The latest version of the SDGs framework, published in 2020 by IAEGSDGs (Inter-agency and Expert Group on

SDG Indicators), is composed of 17 objectives, divided into 169 targets and 231 indicators. Klopp and Petretta investigated the relationship between indicators, complexity and the politics of measuring cities, highlighting the need to reduce the vagueness of indicators to avoid fuzziness between universal and appropriate local implementation. Hansson et al. highlight the need to reprioritize indicators so that they can provide a higher added value in supporting sustainable development governance. Valencia et al. stress the need for adapting and localizing the SDGs targets and indicators, and operations that should be performed together with local policy and decision-makers. As stated by Rudd et al., "[t]he goal's promotion of urban-rural linkages signals a reinvigorated desire from the international community to move from a dichotomous conception of urban and rural development to one of mutually reinforcing".

Badina, Babkin, Bereznyatsky, and Bobrovskiy (2022) provides an assessment of spatial differences of vulnerability levels for the population Moscow to possible natural and man-made hazards, taking into account the actual population size and aspects of its intraday spatial movement. According to the cluster analysis' results, the potentially most vulnerable areas of Moscow were identified, and grouped into six types. The results of the study show the inconsistency of existing approaches to risk assessment based on official social statistics (Rosstat).

Labaran, Mathur, Shehu, and Auwal (2022) reviewed the several contributions of these researchers across the globe towards this dimension. The troubling issues facing the world today are the rising accumulation of greenhouse gases and consequent global warming (Tathagat and Dod, 2015). Ice is melting at unprecedented levels, and natural disasters have become more frequent and more extreme (Jackson, 2020). Climate change has now been proven to be a man-made phenomenon resulting from the injection of massive quantities of GHG into the environment (Jackson, 2020; Monahan Housing and reduction, 2013). According to data from the National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA), the mean temperature of the earth has increased in the last 100 years by about 1.2–1.4 ◦ F (National Construction Sector Lead U.S., 2009). Surenthira S.R., et al. (Stephen Ramachanderan and Kumar Venkiteswaran Yap, 2017) reported that the emissions from the consumption of fossil fuel have increased at an alarming rate (Stephen Ramachanderan and Kumar Venkiteswaran Yap, 2017). After 1850, the eight warmest recorded seasons have all happened from 1998, with the warmest year in 2005 (National Construction Sector Lead U.S., 2009). Much of these warming over the past few decades have possibly resulted from the various human activities (National Construction Sector Lead U.S., 2009). The construction industry made significant contributions during the Industrial age toward the carbon emissions increment in our environment (Jackson, 2020). Constructions account for almost half of all energy usage and use of raw material worldwide (Adebowale Philips Akinyemi et al., 2017). Various construction activities lead to environmental pollution through land clearing, equipment's engine emissions, demolition, burning, and use of dangerous chemicals, among others (Adebowale Philips Akinyemi et al., 2017). In his study on the carbon emissions from the construction industry in Australia (Man Yu, et al.), reported that the direct emissions of greenhouse gases from the construction industry in Australia were estimated to be around 9.5 Mt 2e in 2013 while the carbon footprint was 90.3 Mt of $CO2$ equivalent (Yu et al., 2017). Out of this, construction of residential housing accounted for about 21.5 Mt of the total carbon dioxide equivalent emissions (Yu et al., 2017). While the remaining 14.6 percent, 11.8

percent, 9.9 percent, 4.7 percent, and 4.2 percent are from housing construction, heavy construction, non-housing construction, building imports, and transportation infrastructure (Yu et al., 2017).

Boone, D.J. (2000) will assist in identifying which options are most easily implemented. While written testing had the poorest compliance, the authors point out that the assessment tool chosen should be based on the skill that the laboratory feels is the most important component of job performance.

Tarigan, and Setiawan aims to analyze the effect of employee competence on increasing employee motivation in Sumut Bank of Sharia Unit, North Sumatera. Michael Armstrong in Sudarmanto (2009: 46), Competence is what people bring to a job in the form of different types and levels of behavior. According to Noe (2002: 94), Competence is the ability of individuals to carry out the tasks of their profession which is a combination of knowledge, skills and attitudes. According to Spencer and Spencer in Rivai (2009: 306), states that there are 5 competency characteristics, namely Motives, Traits, Self-Concept, Knowledge and Skills. Ruky (2003), argues the concept of competence is becoming increasingly popular and has been widely used by work units, especially large companies for various reasons. As according to Sybll K. Romley (2008) related to competence said: "Most authorities recognize that competencies generally fall into two categories - hard measures and soft measures. According to Robbins (2010: 109) motivation refers to the process by which a person's efforts are energized, directed, and sustained towards achieving a goal." According to Siagian (2002: 102) motivation is a driving force for someone to make the largest possible contribution for the success of an organization to achieve its goals. Chung & Megginson in Faustino Cardoso (2003: 177) states that "motivation is defined as goal directed behavior, it concerns the level of effort one exerts in pursuing a goal, it is closely related to employee satisfaction and job performance". Motivation according to Greenberg and Baron (2003: 190) is a series of processes that arouse, direct, and maintain human behavior toward achieving goals.

Tjoa, and Tjoa (2016) is aiming at illustrating the potential of ICT for achieving the Sustainable Development Goals which were declared by the United Nations in 2015 as binding for all nations of our planet addressing both developing and developed countries. The impacts of ICT on sustainability are negative effects on sustainability such as the generation of electronic waste, and more efficient resources.

Santoso, Naim, Magna, Hayudini, and Shrestha (2023) aims to analyze the effect of the environment and competence on employee performance at a seafood processing company in Probolinggo City, East Java.

Cik, Asdar, Anwar, and Efendi (2021) aims to analyze the positive influence of learning organization and training on employee competence; the influence of competence on the job satisfaction; and the positive influence of learning organization, training, competence and job satisfaction on employee performance.

Husenovna discusses the disruption of ecological balance, focusing on effects of human activities on ecology. It highlights the negative impacts on the environment plants, humans, and all aspects of human environment, including underwater ecosystems and life on the water surface.

Hajiali, Kessi, Budhiandriani, Prihatin, and Sufri (2022) looked at the impact of work motivation, leadership style, and competence on job satisfaction, as well as the effects of work motivation, leadership style, and competence, job satisfaction's impact, and the impact of work motivation, leadership style, and competence on performance. The study's population and sample size were 125 employees.

In Loïc, L., Grealey, J., and Inouye, M. (2021), a methodological framework to estimate the carbon footprint of any computational task in a standardized and reliable way is presented and metrics to contextualize GHG emissions are defined. A freely available online tool, Green Algorithms is developed, which enables a user to estimate and report the carbon footprint of their computation.

Angon, Mondal, Jahan, Datto, Antu, Ayshi, and Islam (2023) highlight the present status and development of IPM. Advances in technology have now ushered in a new chapter in IPM. After all, there are some limitations to this process. If IoT is used in conjunction with the current pest management technique, IPM will also achieve a new milestone. A number of studies conducted on IPM have been combined.

McDonald, Marois, and Spronk (2021) suggests that private investments in water and sanitation have not materialized as planned due to the sector’s risk return profile. Nearly 2.1 billion people lack access to safe, readily available water at home, and 4.5 billion people lack safely managed sanitation (WHO/UNICEF, 2017). It is expected to cost an estimated US$150 billion per year to meet SDG targets 6.1 and 6.2 (World Bank, 2017: 52). The total global WSS infrastructure development needs are estimated to require US$6.7 trillion by 2030 and US$22.6 trillion by 2050 (Ajami et al., 2018: 5). The most pressing needs are in the Global South, but high-income countries are also in serious deficit situations (Hutton, 2016); the United States requires an estimated US$1 trillion in WSS investment over the next 20 years (Tiemann, 2017: 9). Rather than "categorically dismissing public financing because some of the projects fail", it is important to ask what "well-designed policies for public financing" can look like (Mazzucato and Semieniuk, 2017: 43). Existing public banks will need to open themselves up to closer scrutiny and to be prepared for critical assessments that go beyond the largely market-based quantitative performance indicators that have dominated their internal and external benchmarking to date (La Porta et al., 2002; Cull et al., 2017).

Mironova, Hung, Sizova, and Yuronen (2024) presents the latest findings concerned with environmental problems and solutions in the mining industry using technologies of phytoremediation based on the natural ability of plants to accumulate toxic elements, including heavy metals, in their biomass.

Jones (1972) expresses that the pioneer community is retained through all subsequent stages of holdfast-habitat development, from the first to the seventh year of its growth. The retention of the juvenile component of the community into the mature stages of habitat development was previously described as neotenous community development (Jones 1971). Species diversity, which can be taken as a measure of maturity and stability (Margalef 1968), was consistently greater at the unpolluted stations. Extensive research by SED (1969a, b), Bayn (1963, 1964, 1964a, 1965) and Wilsoi (1968a, b, 1970a, b, 1971) has shown that both Mytilus edulis and Sabeltaria spinulosa produce planktonic larvae which preferentially select their place of final settlement by extending their planktonic phases for many weeks. However, characteristically large numbers of Sabellaria spinulosa and Mytilus edulis in the polluted habitats indicate that these species are able to colonize polluted waters in much greater numbers than in clean waters (cf. Meikovsky 1970). The cause for the rapid turnover of these species was not determined. It could be the result of the natural imbalance in such a simplified system (Levens 1962, 1963, Magal 1967, Odum 1967).

Kembel, et. al (2010) calculates phylogenetic diversity metrics, performs trait comparative analyses, manipulates phenotypic and phylogenetic data, and performs tests for phylogenetic signal in trait distributions, community structure and species interactions. Picante is a software package that provides a comprehensive set of tools for analyzing the phylogenetic and trait diversity of ecological communities.

Ozlu, Arriaga, Bilen, Gozukara, and Babur improve the understanding of CF alteration due to agricultural management and fertility practices. This study aims to improve the understanding of carbon footprint alteration due to agricultural management.

Radjab, Rabiyanti, and Muharby (2023) was conducted at Hutumuri and Rutong waters, Ambon City. This study assessed physical-chemical parameters, sea urchin species composition, classification, and community structure. Results indicated normal temperature and salinity at both stations, supporting sea urchin life, with rocky and sandy substrates deemed suitable.

Mulder (2002) compared over 40 definitions of the concept of competence, and distinguished differences. Weigel and I (Weigel and Mulder, 2006) examined this question in the context of VET development in England, France, Germany and the Netherlands, using work of, among others, Achtenhagen (2005), Arnold et al., (2001), Colardyn (1996), Delamare-Le Deist and Winterton (2005), Ellström (1997), Eraut (1994; 2003), Handley (2003), Mandon and Sulzer (1998), Mériot (2005), Mulder (2006), Mulder et al., (2005), Norris (1991), Rauner and Bremer (2004), Sloane and Dilger (2005), Smithers (1999), Straka (2004), Weinert (2001), and Winterton, Delamare Le-Deist and Stringfellow (2005). At present five competence fields are distinguished, namely, action, subject, personal, social and methods and learning competence (Fischer and Bauer). Competence development is aimed at work activity, or work process knowledge (Rauner). Competence development has a double focus, namely, the individual who tries to master a certain occupation and structural characteristics that determine the way in which an occupation develops, including professional experience (Suleman and Paul). At present, VET development is aimed at introducing a competence-based qualification structure (Van der Klink et al.), to prepare new generations of students for more effective performance in their jobs. The experiences are mixed (Wesselink et al.). There are problems with a tendency to lower mastery of basic skills, reliability and costs of assessments (Roelofs et al.; Biemans et al., 2004; Lans et al., 2004).

Gao, Liu, and Wang (2014) focus on the research methods and steps involved in carrying out studies on different types of carbon footprints. Goals, principles, research boundaries, calculation methods, data selection and other aspects of organizations footprint and product carbon footprint were analyzed.

Muller, et. al (2020) reviews methodological approaches for determining the carbon footprint of captured CO2 as carbon feedstock, and shows why some approaches lead to suboptimal choices of CO2 sources and that increased consistency in life cycle assessment (LCA) studies on CCU is needed.

Andrew (2008) shown that the term “carbon footprint” has gained acceptance in the public domain without being clearly defined in the scientific community. The incorporation of this term into recent peer reviewed literature demonstrates the popularity of the term and its growing acceptance and use even within some scientific literature. International agreement on emissions reductions such as the Kyoto protocol (United Nations 1998) and international publications such as International Organisation for Standardization (2006) and World Resource Institute and World Business Council for Sustainable Development (2008) provide a valuable resource to inform these methodological decisions. A measurement tool should also at a minimum, include the measurement of all six greenhouse gases covered in the Kyoto protocol expressed in greenhouse gas equivalents (United Nations 1998).

Sunatar determine the effect of leadership style and employee competence on employee performance through organizational citizenship behavior. The research is included in descriptive quantitative research. The population was government employees of Sorong city, West Papua with a sample of 30 employees.

Chevy, Atra, Yeti, Rahayu, and Yusuf (2022) discuss about effect of competence and compensation on employee performance. This type of research is a correlational study. The population in this study are employees of PT Bintang Parabola, amounting to 75 people. Wahyuni, Octavia, Karista, Sabna, and Martalia (2025) aims to explore how the belief systems of indigenous peoples influence everyday conservation practices and examine how these beliefs can be integrated into modern conservation.

Kumar, Sharma, and Vashista (2014) explore the apparent discrepancy between public and academic use of the term ‘carbon footprint’ and suggests a scientific definition based on commonly accepted accounting principles and modelling approaches. It addresses methodological question such as system boundaries, completeness, comprehensiveness, units and robustness of the indicator. Pudjowati, Cakranegara, Pesik, Yusuf, and Sutaguna (2022) determine the impact of leadership and employee competence on organizational commitment in Perumda Pasar Juara. This study employs a quantitative approach by distributing questionnaires to 61 field employees from Perumda Pasar Juara. Pradhan, Costa, Rybski, Lucht, and Kropp systematize the identification of synergies and trade-offs using official SDG indicator data for 227 countries. They rank synergies and trade-offs between SDGs pairs on global and country scales in order to identify the most frequent SDG interactions. Verma (2018) comments that there exists a balance between organisms and abiotic factors called ecological balance. This system of ecological balance, taken as a whole is useful to man.

Kowal, Włodarz, Brzychczy, and Klepka (2022) identify the employee competencies that are required in the context of Industry 4.0. They investigated two groups of respondents. These groups were subjected to a comparative analysis of their digital, technical, social and personal competencies. As a result of the analysis, they identified the highest-ranked competencies in defined groups.

Spinellis, and Louridas (2013) comments that the action required to stem the environmental and social implications of climate change depends crucially on how humankind shapes technology, economy, lifestyle and policy. With transport CO2 emissions accounting for about a quarter of the total, they examine the contribution of CO2 output by scientific travel. Haward, and Haas (2021) explore the link between SDG14 and SDG8 as labor and working conditions on fishing vessels receive increasing attention.

Elder, and Olsen (2019) argues that the environment was extensively incorporated into the Sustainable Development Goals (SDGs), with broad and ambitious targets, reflecting environmental concerns throughout the SDGs. Governments rejected a more transformative objective ‘beyond GDP’, the concept of planetary boundaries, and strong implementation mechanisms. The dilution of the indicators resulted from a very different institutional structure and process with different actors and from the development focused legacy of the Millennium Development Goals (MDGs) that had not resulted in sufficient capacity for thoroughly measuring environmental concerns (Giddings et al., 2002; Griggs et al., 2013).

Fukuda-Parr, and McNeill (2019) highlight how the increasing role of big data and other non-traditional sources of data is altering data production, dissemination and use, and fundamentally altering the epistemology of information and knowledge. The research findings show that the SDG experience was an important innovation in more participatory and transparent goal setting, but they also call attention to the pitfalls of ‘governance by indicators (Mahajan; McNeill). Hertwich, and Peters (2009) confirms the conclusions of earlier studies on the importance of consumption categories for the overall house hold environmental impact. Indirect impacts in the supply chain are more important than direct impacts.

Ley, and Albert (2003) is based on the competence performance approach by [Korossy 1997] and [Korossy 1999] which uses mathematical structures to establish prerequisite relations on the competence and the performance level. Albert and Kaluscha (1997) have shown how known methods of adapting competence-performance structures can also be used in dynamic domains. Formal Concept Analysis (Ganter and Wille, 1999) provides an alternative way of formalization for documents and competencies. Busch et al. (2001) have used FCA for mapping knowledge flows (Wöls et al., 2003).

Koch, and Kellenberg (2018) evaluates how three different initiatives translated SDG 11 to the German context, given the specific role of cities in contributing to sustainable development.

Berrone, Rousseau, Ricart, Brito, and Giuliodori (2023) examine the integration of scholarly management literature into practical guidelines for achieving the SDGs. Using these four processes as an overarching framework, they then conducted an interpretive literature review to mine highly cited sustainable development related papers in the management field covering an 11-year period (2010–2020). They identified four universal stages of SDG implementation from popular sources that examined organizational approaches. Their results can also be used to assist consulting firms and managers understand how to better allocate resources towards achieving these broad-purpose societal goals. This observation is consistent with that of Nyberg and Wright (2022). It seems that most research efforts on this topic focused on issues outside the discipline (Wohlgezogen et al., 2021). It is crucial to avoid the trap of simply list-checking steps to continue business as usual (Wright & Nyberg, 2017). Reconciling the economic, social and environmental aspects requires the exchange of a priori preferences with these new dimensions (Hahn & Figge, 2011). Nonetheless, whenever a society demands that private firms internalize the social and environmental costs they generate (Slawinski et al., 2017).

Hoefer, D., and Hammer, T.R. (2011) had a placebo-controlled side-to-side study, run with antimicrobial clothes versus fabrics of similar structure but minus the antimicrobial activity, to evaluate possible adverse effects on the healthy skin microflora. Ivanova, et. al (2017) develops an inventory of carbon footprints associated with household consumption for 177 regions in 27 EU countries, thus, making a key contribution for the incorporation of consumption-based accounting into local decision-making. Their analysis highlights the spatial heterogeneity of embodied GHG emissions within multiregional countries. Serbov (2018) had assessment of the conditions for sustainable and balanced development of economic and ecological systems of Ukrainian water basins developed.

The **Sustainable Development Goals** consist of **17 goals** that address global challenges such as poverty, inequality, climate change, environmental degradation, peace, and justice. Adopted by all United Nations Member States in 2015, these goals provide a shared blueprint for peace and prosperity for people.

Importance of the SDGs

The SDGs are interconnected and recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs, including education, health, and job opportunities, while tackling climate change and environmental protection. Achieving these goals requires global cooperation and commitment from all countries, regardless of their economic status.

Taking Action

To achieve the SDGs, it is essential for individuals, communities, and governments to take action. This includes raising awareness, implementing sustainable practices, and supporting policies that align with the goals. The SDGs provide a framework for addressing the most pressing challenges facing humanity.

History

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all. The SDGs build on decades of work by countries and the UN Department of Economic and Social Affairs

- In June 1992, at the Earth Summit in Rio de Janeiro, Brazil, more than 178 countries adopted Agenda 21, a comprehensive plan of action to build a global partnership for sustainable development to improve human lives and protect the environment.
- Member States unanimously adopted the Millennium Declaration at the Millennium Summit in September 2000 at UN Headquarters in New York. The Summit led to the elaboration of eight Millennium Development Goals (MDGs) to reduce extreme poverty by 2015.
- The Johannesburg Declaration on Sustainable Development and the Plan of Implementation, adopted at the World Summit on Sustainable Development in South Africa in 2002, reaffirmed the global community's commitments to poverty eradication and the environment, and built on Agenda 21 and the Millennium Declaration by including more emphasis on multilateral partnerships.
- At the United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro, Brazil, in June 2012, Member States adopted the outcome document "The Future We Want" in which they decided, inter alia, to launch a process to develop a set of SDGs to build upon the MDGs and to establish the UN High-level Political Forum on Sustainable Development.
- In 2013, the General Assembly set up a 30-member Open Working Group to develop a proposal on the SDGs.
- In January 2015, the General Assembly began the negotiation process on the post-2015 development agenda. The process culminated in the subsequent adoption of the 2030 Agenda for Sustainable Development, with 17 SDGs at its core, at the UN Sustainable Development Summit in September 2015.

- 2015 was a landmark year for multilateralism and international policy shaping, with the adoption of several major agreements:
  - Sendai Framework for Disaster Risk Reduction (March 2015)
  - Addis Ababa Action Agenda on Financing for Development (July 2015)
  - Transforming our world: the 2030 Agenda for Sustainable Development with its 17 SDGs was adopted at the UN Sustainable Development Summit in New York in September 2015.
  - Paris Agreement on Climate Change (December 2015)

The Division for Sustainable Development Goals (DSDG) in the United Nations Department of Economic and Social Affairs (UNDESA) provides substantive support and capacity-building for the SDGs and their related thematic issues, including water, energy, climate, oceans, urbanization, transport, science and technology, the Global Sustainable Development Report (GSDR), partnerships and Small Island Developing States. **Global Sustainable Development Report** is produced once every four years to inform the quadrennial SDG review deliberations at the General Assembly.

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Research Gap

From the above review discussion, it becomes clear that well lesser empirical studies are held on the topic in Indian context and further, no study has been found executed till date on India as a whole on this particular phenomenon in empirical perspective.

Key Contribution

Previous study results slightly contravene the existing text, whereas instead of UTAUT explained about 70 percent of the variance in behavioral intention to use a technology and about 50 percent of the variance in technology use, the recently held initial study on same perspective on postal study exhibited about 81 percent of behavioral intention to use a technology and about 34 percent technology use.

Strengths

The study's robustness includes a large sample size across the megacities of India bringing a holistic view, with more extended and novel methodologies on the sector and perspective, with new insights on the postal, banking and insurance segment of India Post from this perspective. Coverage from the Megacities strengthen the validity, reliability, or applicability of the findings.

Limitations

For the initial study, having a limited sample from educated youth with no sampling or cluster-based restrictions may have impacted the results, such as small sample sizes, biases, or methodological constraints. For specific rural and remote pockets, the data was and seems to be inconclusive.

Method, Experiments and Results

Nature of Research: Seeks to understand and improve user technology adoption behavior, decision-making, and socio-psychographic dynamics.

It is a three phased research with Initial field screening in 6 Megacities (Delhi, Calcutta, Chennai, Bangalore, Hyderabad, Mumbai) key authorities housed at CPMG headquarters, GPOs, HOs and other key postal authorities situated in the above megacities catchment regions. So far research has completed on the northern, southern, western and eastern stretch of the country for respective offices.

Sample: Research from all GPOs, Megacities HOs and Megacities' Catchment Metropolitans' HO.

Sampling: 200 Each of 6 Megacities (Delhi, Calcutta, Chennai, Bangalore, Hyderabad, Mumbai), 100 from the each of above Megacity' Catchment Metropolitans HO. 200 as a whole from GPOs spread across India.

Methods: Combining quantitative and qualitative approaches to capture nuanced insights.

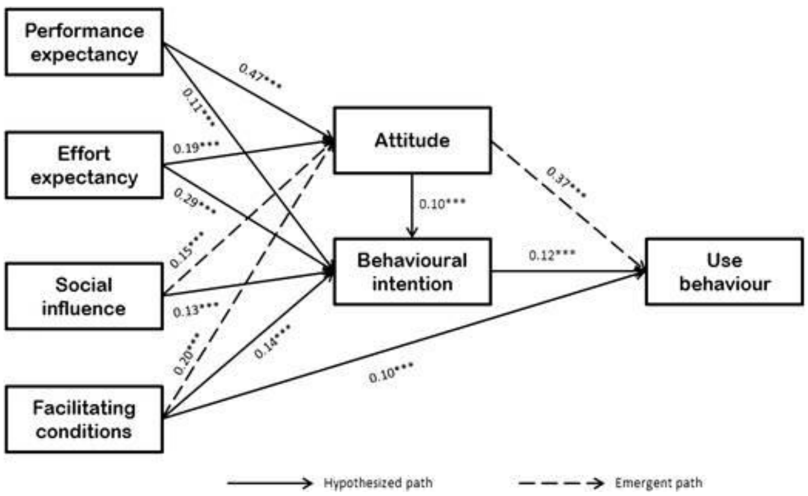

Figure 2. A popular UTAUT research model stressing usage of attitude as an intermediate and concomitant variable.

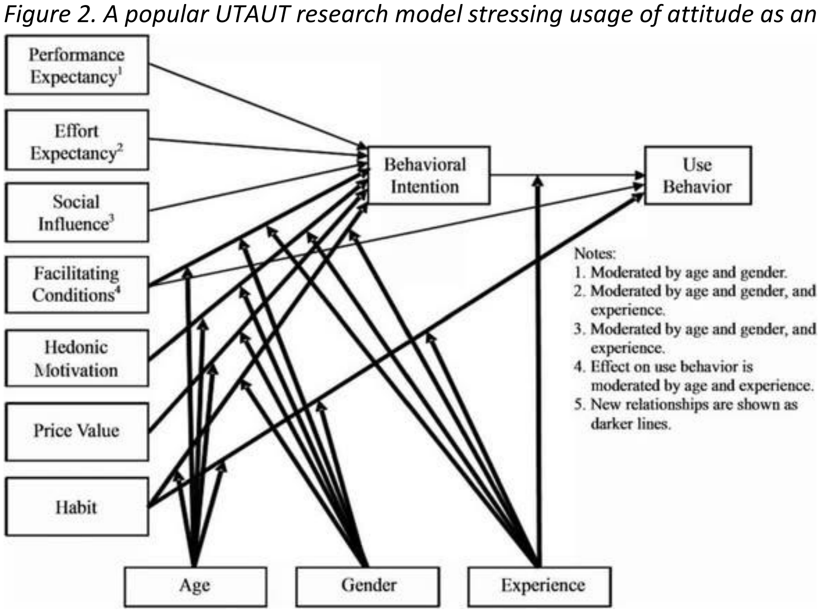

Figure 3. A popular UTAUT research model stressing usage of age gender and experience as a concomitant variable.

Experiments:

Field Experiments: Field visits held to ask for the applicability of the UTAUT model to the postal services as well as usage of UN-SDG convergence in postal operation. A field survey of around 2000 respondent will follow later this year, as per the earmarked stages.

Lab Experiments: The collected survey data will be tested using analytical tools and techniques, putting different control variables, as per the applicable model(s).

Behavioral Economics Experiments: Exploring how psychological factors influence economic decisions.

Variation: Management experiments often balance between controlled environments and real-world applications, focusing on both measurable outcomes and human behavior. Hence, that could cause a variation in the results for Indian Postal Sector, as had in initial study as well.

SDGs found held on (in observed circles)

- SDG3: 1 + 1 + 1 + 1 + 1
- SDG5: 1 + 1 + 1 + 1
- SDG8: 1 + 1 + 1 + 1 + 1 + 1
- SDG9: 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1
- SDG10: 1 + 1 + 1 + 1
- SDG11: 1 + 1 + 1 + 1 + 1 + 1 + 1
- SDG12: 1 + 1 + 1
- SDG13: 1 + 1 + 1 + 1
- SDG16: 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1
- SDG17: 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1

SDGs suggested by Guide

- SDG1: Poverty (Services & Financial Inclusion)
- SDG3: 1 + 1 + 1 + 1 + 1
- SDG4: Education (Campaigns, Help, Workshops)
- SDG5: 1 + 1 + 1 + 1
- SDG17: 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1

Discussions

With the project instrument developed with upheld review results, supervisors' suggestions as well as having the partial outcomes of initial field screening, data collection assumed in recent months. Initial field screening has been completed, and research instrument have been developed post considering above all, a permission request was made to postal authorities for research from users at the offices.

Conclusions

As digital disruptions impose greater demands on IT systems and organizations, companies must consider an end-to-end approach for upgrading and managing business technologies. Where, most companies face critical IT modernization issues.

1. Problem statement Addressed/ Motivation

Perspectives and innovations in technology modernization are looked for and sought after for the services offered by the Indian postal services. Hence, we taken an objective to the assess the relevance and operationalization of alike initiative in department of posts. The proposed research aims assessing the perspective of relevant stakeholders on the recent initiatives held on behalf of technology modernization in postal and allied services. **The Research** seeks to understand and improve user technology adoption behavior, decision-making, and socio-psychographic dynamics.

2. Method used

The research has 3 stages in total, with the first two already executed, as follows: (a) **Initial Survey**: 300 respondents from India; (b) **Initial Screening**: 6 Megacities from India; (c) **Main Survey**: Megacities and Catchments. We look to extend the approach followed in our recent study (**Initial Survey**), referring methodology opted in latest studies in recent past, where collected primary data by way of pre-structured questionnaires from the users of India Post. It is three phased research with Initial field screening in 6 Megacities (Delhi, Calcutta, Chennai, Bangalore, Hyderabad, Mumbai) key authorities housed at CPMG headquarters, GPOs, HOs and other key postal authorities situated in the above megacities' catchment regions. So far research has completed on the northern, southern and western stretch of the country in this regard, with having that left for the east of the country for respective offices.

Sample will be from all GPOs, Megacities HOs and Megacities' Catchment Metropolitans' HO.

Sampling would be covering 200 Each of 6 Megacities (Delhi, Calcutta, Chennai, Bangalore, Hyderabad, Mumbai), 100 from the each of above Megacity' Catchment Metropolitans HO. 200 as a whole from GPOs spread across India, except above.

Methods integrate Quantitative Studies, Qualitative Studies, Mixed Methods and Simulation and Modelling.

Field visits were held to ask for the applicability of the UTAUT model to the postal services as well as usage of UN-SDG convergence in postal operation. A field survey of around 2000 respondent will follow later this year, as per the earmarked stages. The collected survey data will be tested using analytical tools and techniques, putting different control variables, as per the applicable model(s). Behavioral Economics Experiments will be exploring how psychological factors influence economic decisions.

3. Key findings

Previous study results slightly contravene the existing, whereas instead of UTAUT explained about 70 percent of the variance in behavioral intention to use a technology and about 50 percent of the variance in technology use. The recently held initial study on same perspective on postal study exhibited about 81 percent of the variance in behavioral intention to use a technology and about 34 percent of the variance in technology use.

SDGs found held on (in observed circles' field visits) include SDG9, SDG16, SDG17, SDG11, SDG8, SDG3, SDG5, SDG10, SDG13, SDG12. SDGs suggested by Guide include SDG1, SDG3, SDG4, SDG5 and SDG17. They will be included in consideration towards later development of research instrument. The study's robustness includes a large sample size across the megacities of India bringing a holistic view, with more extended and novel methodologies on the sector and perspective.

4. Limitations of the work and future work that should be carried

Management experiments often balance between controlled environments and real-world applications, focusing on both measurable outcomes and human behavior. Hence, that could cause a variation in the results for Indian Postal Sector, as had in initial study as well.

For the initial study, having a limited sample from educated youth with no sampling or cluster-based restrictions may have impacted the results, such as small sample sizes, biases, or methodological constraints.

For specific rural and remote pockets, the data was and seems to be inconclusive or where further research is needed. We may not be covering the unregistered and retail segments in the proposed study, as mostly adapting technology and recording the improvement in specific may not be a feasible case.

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