

A SYSTEMS THINKING APPROACH TO NAVIGATE INTERLINKAGES TO ACHIEVE SDGs IN INDIA

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Abstract: While there has been much talk about the integrative, indivisible, and interlinked strategies to achieve the SDGs (UN Sustainable Development Goals), the interactions and interdependencies are generally not explicit. Challenges remain to simultaneously capture the multilayered relationships among SDGs to strategically and coherently align national development plans. In this paper, we use systems thinking and systems dynamics modelling analysis to capture the cross-effects of intervention policies by taking one national indicator for each of the three selected goals. These are budget inclusiveness (increase in public expenditure on health) in SDG 3 (on good health and well-being), literacy rates (literacy rate of youth in the age group of 15-24 years) in SDG 4 (on quality education) and equity (employment gender bias) in SDG 5 (on gender equality) together to assess their effect on the SDG 8 (of decent work and economic growth). A Causal Loop Diagram (CLD) has been used to present the qualitative structure of the model. In our modelling, we logically draw interlinkages and then attempt to support them with existing evidence. Our main result is to confirm that reinforcing loops of such interventions exist, which are important for sustainable development policy. We have extended the Causal Loop Diagram (CLD) by proposing what effects could be realised in other SDGs related to poverty (SDG 1), sustainable consumption and production (SDG 12), and global partnerships (SDG 17). The paper concludes that such analysis will bring interlinkages to the foreground for prioritising the national goals and targets and hence implement policies in priority areas achievable by 2030 for India on a development strategy informed by systems thinking.

Keywords: Systems thinking, Causal Loop Diagram (CLD), SDGs, policy coherence, national development planning.

Introduction

The execution of the 2030 Agenda for Sustainable Development adopted by India along with 192 countries collectively underpinning 17 Sustainable Development Goals (SDGs) and 169 targets commenced on January 1st, 2016. Unlike the Millennium Development Goals of 2000, the new agenda is people-centred, universal, transformative, integrative and holistic. The main objective is to balance economic, social and environmental dimensions of the complex problems of sustainable development at hand and to explicitly bring policy coherence among these many dimensions and the SDGs in tandem with national development plans in sync with global development plans. The vast literature

in this domain seeks integrative approaches and calls for a systems-based approach to sustainable development (Kopainsky *et al.*, 2010; Saeed 2016; Costanza *et al.*, 2016; Anderson 2021). Illuminating and understanding the many interlinkages within and between SDGs' goals and targets, embedded in the systems approach, will explicitly highlight why Agenda 2030 must be considered an 'indivisible' whole. Nevertheless, these studies have focused on the global scale rather than country-specific frameworks.

In this regard, in India, NITI Aayog – the Government of India's public policy is responsible for helping the country achieve SDGs. It seeks to bring together state

governments in the economic policy-making process under the objective of cooperative federalism and includes a “15-year road map” “7-year vision, strategy and action plan” (NITI Aayog). Since it was established in 2015, it has been commended for replacing the “top-down” and “whole-of-government” approach of the Planning Commission with a bottom-up approach. The main objective of NITI Aayog inefficiently leading India on the path of SDGs is two-fold: Proactively prioritise goals and targets and provide a database on all indicators of SDGs in India. Recent assessments show that India’s position on the SDG index has been steadily increasing till 2019 but has faced challenges since the onset of 2020 (Sustainable Development Report, 2022). However, considering the roadmap of the NITI Aayog implementation and localisation of SDGs in the nation based on the motto of Sabka Saath Sabka Vikaas (Collective Efforts for Inclusive Growth), NITI Aayog with The Ministry of Statistics and Programme Implementation (MoSPI) established interactions on the central sector schemes and ministries of the Government of India for every SDG in a concrete form as a first step on the practice of achieving integrated, indivisible and interlinked sustainable development. For example, SDG 1 on “End poverty in all its forms everywhere” links to SDGs 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, centrally sponsored schemes such as the development of skills (Umbrella Scheme), Prime Minister Employment Generation Programme (PMEGP), Atal Pension Yojana (APY), Rashtriya Gram Swaraj Abhiyan (RGSa) and Infrastructure of Disaster Management held under their concerned ministries. There are still gaps in identifying synergies and trade-offs among the SDGs that would facilitate a policy of coherent and balanced development actions.

Deliberately enumerating these linkages is as important as adopting the Agenda itself. The question cannot be how many SDGs will be achieved by 2030 because no SDG can be considered in isolation. The shift in focus is to establish explicit linkages and identify various trade-offs and synergies in India to align the

national development plans and policies. Knowing the nature and strength of these interactions to manage the risk and benefits of achieving various goals is even more important. The nature of the interactions should be acknowledged before policies can be formulated, given the local or national targets and indicators. Consequently, a useful knowledge base will be available for policy-level decision-making and implementation strategy development (Griggs *et al.*, 2017). No study has yet identified such evolving interactions in the Indian context. This study seeks to fill these gaps by undertaking a qualitative analysis, providing arguments for interlinking the three crucial SDGs regionally and addressing the questions listed below: What does the literature hold on the interactions of the various parameters in the Indian economy? What is the strength of these interactions? How can these act as levers or drivers of change following a systems approach? How can this knowledge provide a basis for further analysis considering the national indicators and acting in the real policy world?

Vast literature seeks to provide supporting tools for identifying and understanding interlinkages qualitatively using ratings/scales based on the strength of interaction and quantitatively using Spearman’s rank correlation coefficient (Pradhan *et al.*, 2017; Warchold *et al.*, 2020). A simple tool or framework for classifying such interactions between SDGs along a scale of interaction running from -3 to +3 was proposed by Nilsson *et al.* (2016). These ratings are: -3 Cancelling, -2 counteracting, -1 constraining, 0 consistent, +1 enabling, +2 reinforcing and +3 indivisible. With a policy integration focus, Nilsson *et al.* (2018) further discussed the various dependencies, horizontal and vertical interactions and coherence relationships highlighted as sectoral, transnational, governance, multilevel, and implementation coherence. This study draws on the qualitative interaction frameworks in Nilsson’s framework and dives deeper into establishing linkages among SDG targets in India. Acknowledging the system’s feedback

structure is essential in designing coherent policies. From a system's perspective, many such feedback loops explicitly bring together the holistic view of a country's development.

In this paper, we aim to present this feedback structure of the sustainable development goals using the Causal Loop Diagrams (CLD) for aligning India's national development plan with Agenda 2030. We present a CLD with the focus on magnifying the impact of three crucial SDGs for India: 3 (on health), 4 (on education) and 5 (on gender equality) on SDG 8 (on economic growth and employment) qualitatively. To do this, we use one national indicator closest representative of the selected target from the Sustainable Development Goals National Indicator Framework (NIF) for each goal and extend it to highlight the impacts of SDG 8 on three further SDGs: 1 (on poverty), 12 (on sustainable consumption and production) and 17 (on global partnerships). Such efforts based on integrative approaches to build policy coherence would enable India to capture, analyse and quantify interconnections and prioritise its strategies and goals in implementing its overall SDG agenda. However, supporting these links with a quantitative analysis requires the appropriate data on the selected parameters and standard system dynamic tools to understand such correlations, which is beyond the scope of this study.

Methodology

The overall theoretical frameworks of this paper are systems thinking and systems dynamics. It is important to understand that a system is comprised of several interconnected elements arranged in such a way as to accomplish a specific goal. A formal, existential, or affective system consists of three main components: Elements, interconnections, and a function or purpose (Meadows, 2008) to form a complex whole. Studying these systems themselves is an approach cum solution for many to see the world as a complex system, to study how everything is connected with everything else rather than

analysing the components alone. Senge (1990) describes systems thinking as "a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things and patterns of change rather than static snapshots. Systems thinking is a discipline for seeing the structures underlie complex situations and discerning change in high and low leverage".

Systems analysis is studied in terms of "links" and "loops" of the systems' dynamically complex behaviour. Causality and interrelations between its constituents hence define dynamic systems, often through several degrees of feedback loops which carry ripples of impacts from any systems driver to any other, thus, often leading to emergent phenomena defined beyond the sum of the system's constituents (Collste *et al.*, 2017).

One application of systems thinking is systems dynamics. System dynamics—through stocks, flows, feedback loops, time delays, and functions - is an approach to understanding the non-linear complex behaviour of systems over time rather than at a point in time. Systems dynamics modelling, more commonly known as 'system dynamics', originated from pioneering work at MIT in the 1950s by Jay Forrester. Table 1 summarises the dynamic complexities of our world, which systems dynamics can explicitly tackle.

Understanding the causal relationships between variables in a system becomes increasingly important. These can be represented and analysed by various methods, from graphical representation to computer simulations to analysing by mathematical models. The basic step in the dynamical analysis of a system is the construction of causal loops of mutual causality. Thus, system dynamics—via CLD and stock-flows diagrams (SFD) - is the study of dynamic feedback systems qualitatively, Figure 1.

To study the interlinkages among the sustainable development goals from the systems view, we construct CLD presenting the qualitative models to access the impact of the intervention policies selected under goals 3, 4 and

Table 1: Key concepts of narrowing dynamic complexity of the real world (Sterman, 2000)

Property	Description
Dynamic	Systems are constantly changing. Change takes place in different time scales. Even if change does not appear in the short term, the long term might vary.
Feedback loops	The interrelations within the components of a system arise due to the feedback effect. Every component of a system has other components whom it influences and is influenced by arises due to feedback loops. These relations give rise to rich interactions.
Tightly coupled	Components of a system possess patterns of relations within and outside the system. Everything is connected to everything else. These interrelations become important to recognise when dealing with systems as a whole.
Non-linearity	Dynamic interactions are often non-linear. Cause and effects are rarely proportional.
History-dependent	Decisions or actions are often dependent on previous decisions made in the past.
Self-organizing	The interactions among the components of a system give rise to complex and dynamic behaviour which arises internally.
Adaptive	The behaviour of agents or actors involved in a system changes over time as they learn and combine experiences and knowledge to achieve their goals in the face of obstacles.
Trade-off	Time delays in a feedback effect often relate that the long-term effect of an intervention can be different from the short-term effect. They are trade-offs involved in deciding the interventions' effects on a system.
Counterintuitive	In complex systems, cause and effect are separated through time and space, leading to behaviour that is difficult for human agents to follow. The focus should be on the symptoms rather than the causes.
Policy resistant	The complexity of a system might be difficult to understand. Policies implemented without understanding the whole system can cause failures or worsen the situation.

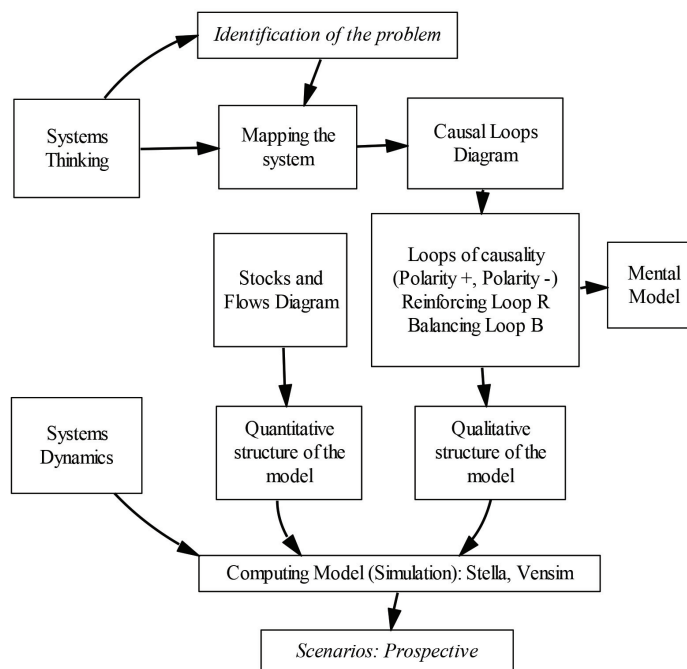


Figure 1: Brief description of systems thinking and systems dynamics (Khushik & Diemer, 2021)

5 in promoting economic growth, employment and productivity as are the targets under the goal 8. Our approach is two-fold: First, an attempt is made to build multiple linkages considering individual intervention policies logically and second, these linkages have been supported with existing literature in the Indian context. Our analysis of sketching the CLD is supported by the causal loop mapping developed in the two SDG models: iSDG and SDG Synergies, developed by the Millennium Institute and Stockholm Environment Institute, respectively. The Integrated Sustainable Development Goal (iSDG) Model (Millennium Institute) is a policy-guiding tool to establish policy coherence among all 17 SDGs by simulating desired interventions while aligning Agenda 2030 with the national development plan and objectives. Based on T21 technology (Barney *et al.*, 1995), it is a modelling methodology to study complex, dynamic systems. Both models generate scenarios tracking the dynamic interrelationships through feedback between economic, environmental, and social domains of development planning. From the model's perspective, economic activities occur within the society and the broader natural environment, leading to an understanding of the holarchy of seeing the wholes, an important concept of complexity theory and systems thinking. The model traces the trend up to 2050, i.e., beyond the SDGs period, to develop medium to long coherence and impact of the policies. SDG Synergies tool (Weitz *et al.*, 2019) using systems thinking is a participatory, discussion-based scoring process to understand how policy agendas and goals interact. It develops a cross-impact matrix of interactions between all the objectives and targets being considered to analyse how progress in one might affect progress in another and vice versa, using

advanced network analysis and visualisation capabilities to study complex relationships.

As noted earlier, the language of systems thinking is loops and links. An arrow representing a link polarity is used for every variable affecting the other. The arrow here is representative of a causal influence (A causes B, B causes C, Z causes A, representing both a consequence and a cause) with link polarity taken to be positive or negative. Two feedback loops are important: The balancing loop and the reinforcing loop. A balancing loop (B), often known as negative feedback and represented by – polarity leads to a goal-seeking or balancing behaviour. A reinforcing loop (R), often known as positive feedback and represented by polarity leads to growth in a state of the system and continues at an ever-increasing rate until some exogenous factor hits or limits the growth. Feedback is never instantaneous and may come within fractions of seconds, months, or years. Thus, feedback often comes with time delays, which contributes to creating complex dynamics in the system. In addition, CLD also help to identify how to change the structure of the system to produce more of what we want and less of something undesirable. Meadows (2008) calls to look for leverage points (referred to as points of power), i.e., places in the system where a slight change could lead to a large shift in behaviour (Table 2). In particular, the CLD we have used in our analysis help us to identify leverage points to guide synergistic and systemic policy decisions, specifically in our chosen SDGs.

Table 2: Places to intervene in the system (in increasing order of effectiveness)

12. Numbers—Constants and parameters such as subsidies, taxes, standards
11. Buffers—The sizes of stabilising stocks relative to their flows
10. Stock-and-flow Structures—Physical systems and their nodes of intersection
9. Delays—The lengths of time relative to the rates of system changes
8. Balancing feedback loops—The strength of the feedback relative to the impacts they are trying to correct
7. Reinforcing feedback loops—The strength of the gain of driving loops
6. Information flows—The structure of who does and does not have access to information
5. Rules—Incentives, punishments, constraints
4. Self-Organisation—The power to add, change, or evolve system structure
3. Goals—The purpose or function of the system
2. Paradigms—The mindset out of which the system—its goals, structure, rules, delays, parameters—arises
1. Transcending paradigms

Mapping Causalities

In this section, we investigate the relationships between SDGs 3, 4 and 5 with SDG 8 identified as their representative national indicator (Figure 2). This will enable us to logically interpret the interlinkages qualitatively and sketch our CLD drawn on the arguments and supported by the literature. Causal connections may be positive or negative. For example, school enrollment

which implies a higher literacy rate among the youth between 15-24 years, may affect the Gross Domestic Product (GDP) growth positively through higher total factor productivity, or an increase in the gender employment gap can negatively affect the progress on providing decent work for all men and women and equal pay for work of equal value. We will explore below all the relationships separately.

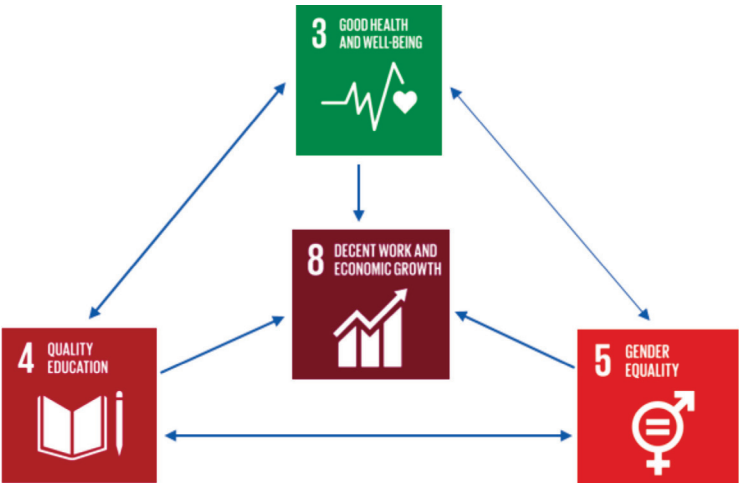


Figure 2: Potential causal chains between SDGs 3, 4, 5 and 8 based on the selected indicators. Detailed view in Figure 3

The Effect of Health and Well-being on SDG 8

World Health Organization (WHO, 2006) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity”. SDG 3 on “good health and well-being” deals with a multi-faceted concept of health. The goal achieves to ensure healthy lives and promote well-being at all ages to address the various emerging health issues of the ever-changing world comprising universal health coverage, access to safe and effective medicines, maternal and child health and communicable and non-communicable diseases. Therefore, health and well-being lie at the core of sustainable development goals. Better health and protection from the disease are not just fundamental to survival but have the potential to build stronger foundations for economic growth and prosperity (United Nations in India). Health is crucial in the overall development of the human capital of a country. A healthy citizenry can impact economic growth in numerous ways:

- A healthy population will be more productive as it will mean a lower absenteeism rate from school, which improves learning among children, less frequent leaves from work which reduces production losses due to worker illness and better cognitive functions, which increases productivity in adults due to higher nutrition. This positively affects adult literacy rates, total factor productivity, efficient human capital, higher income, and higher economic growth of an economy among various factors.
- A healthier workforce, earning decent incomes, will tend to save more than spending on medicines and treatment. These savings can be invested in productive activities and efficient allocation of capital (wealth), which leads to higher production, efficient utilisation of factors of production, higher incomes, and higher economic growth.
- A healthier population also contributes to lower mortality rates and total fertility rates. Healthier children will mean fewer children on average. As a result, this will also affect the life expectancy of the population since they will be eating healthier and suffering from fewer diseases.
- All this essentially represents a one-way positive linkage from a healthier population towards finding productive employment, higher incomes, and higher economic growth, but this is not an end in itself. A higher GDP of the economy reflects economic growth and provides a larger capacity for government to finance expenditures on good health in the economy. Larger resources at the government's disposal will benefit it by spending higher on public health and other areas, giving way to feedback into the system and positively generating non-linear effects for the overall economy.

The Ministry of Statistics and Programme Implementation, Government of India, in its Sustainable Development Goals National Indicator Framework (NIF), defines 13 targets and 42 indicators for measuring the progress made in the country on this front. We use one national indicator representative of SDG 3, i.e., “Percentage of government spending (including current and capital expenditure) in the health sector to GDP” reflected under the target 3c to “Substantially increase health financing and the recruitment, development, training, and retention of the health workforce in developing countries, especially in the least developed countries and small island developing States” as an intervention policy in our modelling of causal loops. Public Health Expenditure (PHE) (as a percentage of GDP) is an indicator of good health and well-being reflected in the efforts made by the government of any country to promote health welfare. PHE is considered a development strategy that contributes to higher per capita income and improves the quality of all

aspects of human life. Thus, it forms an integral part of the inclusiveness budgets strategies to benefit all people in their diversity. PHE gets space in our modelling as an intervention made by the government in achieving SDG 8.

The above logically drawn arguments indicate positive causality of expenditure on public health as our intervention policy under SDG 3, with economic growth and productive employment in SDG 8. This will be incorporated into a CLD (Figure 3) represented by positive polarity by checking if the literature holds in the Indian context and is discussed further in the next section.

The Effect of Education on SDG 8

Education is a complementary aspect of health for human development. As much as health is important for SDGs, so is quality education. Sustainable Development Goal 4 calls for eliminating all gender disparities in quality vocational, technical, and higher education while ensuring completion of primary and secondary schooling by 2030 (United Nations in India). Education is hence seen to enable self-reliance, boost economic growth by enhancing skills and improve lives by unfolding opportunities for better livelihoods (ibid.).

Education¹ itself can be an important determinant of economic well-being, particularly in the following ways:

- An educated workforce positively impacts labour productivity, directly improving human capital efficiency at the workplace by enhancing skills and knowledge, thus, increasing economic growth.
- Education increases the innovative capacity of the people and thus will lead to the emergence of novel technologies, ideas, designs, products and processes that accelerate growth.
- Education will enhance the ability of people to learn newer technologies and

understand newer opportunities devised by others for promoting economic growth (Lucas Jr. 1988; Romer, 1990). Introduced as ‘absorptive capacity’ by Cohen and Levinthal (1990) as ‘the ability to recognise the value of new, external information and to assimilate and apply it’.

SDG 4 on quality education ensures inclusive and equitable quality education and promotes lifelong learning opportunities for all. Among 10 targets and 19 indicators identified at the national level by the Government of India to measure the inclusive and equitable quality education and promote lifelong learning opportunities, we use the Literacy rate of youth in the age group of 15-24 years (in percentage) reflected under the target 4.6 of “Ensuring that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy by 2030” as our intervention policy and a basis to determine the effects of education on SDG 8.

Three aspects become crucial: (1) All men and women must be treated equally in education. (2) Quality of education matters the most. Rather than focusing on the citizens just being in school, the shift in focus is now on what they learn in school and (3) Looking at the literacy rates in youth does not ignore that literacy rates at primary and secondary levels are the main influencers of literacy rates at the tertiary level of education. The youth in the age group of 15-24 years are most likely to get employed. A higher literacy rate among the youth will enhance their capacity to land productive jobs and use their skills and knowledge to create, innovate, and adapt to newer opportunities. Hence, the attainment of quality education becomes vital for economic growth from the early life of children. Thus, net school enrollment in early childhood may produce a delayed link to literacy rate in youth given less or negligible school dropout rate.

¹ While we treat education instrumentally as defined for SDG 4 purposes, we recognize its importance as end in itself in enabling people to reach self-actualization and live a life they consider worth living.

Although the major effects of literacy rate in youth on economic growth and employment appear to be positive, the discussion in the results section below suggests how early school enrollment affects literacy rate and average years of schooling to gather a holistic view of this intervention's spill-over effects to SDG 8. This gives us the basis to verify our arguments with the literature and further incorporate them into Figure 3, bringing an explicit causal relationship.

The Effect of Gender Equality in Employment on SDG 8

Education and health are key determinants of human talents, skills, productivity, and efficiency. Nevertheless, how and under what conditions will this potential gain in economic growth and employment be realised will depend on the gender gap in employment. Addressing inequalities thus, obtains utmost importance in achieving SDG 8's targets of full and productive employment, decent work, and equal pay for equal work without any discrimination based on gender. Gender equality is not only a fundamental human right, it naturally lays a foundation for other SDGs to attain a peaceful, just and sustainable development and hence secure an equal place as Goal 5 to "achieve gender equality and empower all women and girls". Encouraging women and girls to participate in all political, economic, and public spheres, with national policies and national laws of getting equal rights at work, valuing women's work at home and ending all forms of violence against them would not only benefit women (half of the world's population) but also humanity at large.

In this paper, we are concerned with the gender gaps in employment, which specifically relate to cultural and social bias, rather than gender gaps in employment about education and productivity and thus, can be linked to economic growth and employment in accordance with:

- The first pathway could be directly related to labour markets, i.e., the productivity

of labour and how the human capital is optimally utilised. Gender gaps act as brake and tend to reduce the average talent of the workforce. Thereby, the average ability of the working population and economic growth both decline.

- Another pathway operates through increased women's bargaining power in the home through female employment and earnings, which not only empowers the concerned women but can have several growth-augmenting effects, including higher savings as women and men differ in their savings behaviour, more productive and higher investments towards health and education of their children, thus, promoting human capital of the next generation and consequently economic growth.
- A second factor associated with women's bargaining power is the reduction of fertility rates, thereby reducing the burden of dependency and increase in the supply of savings.

SDG 5 aspires to empower all women and girls through equal rights in education, health care, decent work, economic resources, and representation in political decision-making processes. A total of 28 indicators have been identified at the national level in India to monitor the progress of these targets. We particularly focus on indicators 5.5.1: Proportion of seats held by women in national Parliament, State Legislation and Local Self Government (in percentage) and 5.5.2: Proportion of women in managerial positions including women in Board of Director, in listed companies (per 1,000 persons) defined under the target 5.5 to "Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life" which matches closely to analyse the effect of our intervention based on the Gender gap in employment in SDG 5 on the targets of SDG 8.

Results

The arguments in the previous section have provided a base to present causal relationships we expected in public expenditure, literacy rates in youth and gender equality in employment on economic growth, workforce productivity and employment. Thus, Table 3 represents the supportive literature in the Indian context.

Furthermore, there are links among our three SDGs chosen for this study as listed down below:

- Education (SDG 4) and health (SDG 3) are particularly seen as reinforcing, with good health and nutrition improving the attainment of education, while education

enhances healthy lifestyles and reduced fertility rates. One aspect of education impacting economic growth and employment of a country through higher total factor productivity has been indirectly linked to health. A healthier workforce will find fewer reasons to leave schools, attain knowledge and find better jobs which consequently contribute to higher economic growth and a lower unemployment rate.

- Gender equality (SDG 5) and education (SDG 4) are inextricably linked. Education in the Agenda 2030 recognises that all women and men gain equal access to inclusive and quality education and are empowered equally through education. Education has

Table 3: Overview of prominent literature in the Indian context in drawing linkages between specified SDG indicators chosen and SDG 8 targets

SDGs	Cited Literature	List of Linkages Drawn
SDG 3 and SDG 8: Public Health Expenditure (PHE) and economic growth	Mohapatra (2017); Kaur (2020); Ray & Sarangi (2021)	1. Uni-directional linkages incorporate delays in the CLD as PHE is social spending. 2. PHE as intervention directly impacts health care spending and basic access to health, consequently, nourishment, cognitive functions, and total population.
SDG 4 and SDG 8: Literacy rate of youth in the age group of 15-24 years and economic growth	Wang & Liu (2016); Kotásková <i>et al.</i> (2018); Sebki (2021)	1. Quality of education holds primary importance (Hanushek & Woßmann, 2010; Sauer & Zagler, 2014; Ahsan & Haque, 2017; Dutt & Veneziani, 2020). 2. Positive links were observed between education at tertiary enrollments, government expenditure on education, female enrollment rates on fertility rates, human capital, economic growth and productivity.
SDG 5 and SDG 8: Gender equality in employment and economic growth	Sehrawat & Giri (2017); Andres <i>et al.</i> , (2017); Chatterjee <i>et al.</i> , (2018) Desai & Joshi (2019);	1. Greater role of women in social, economic and political spheres to impact economic growth directly and indirectly. 2. Declining female labour force participation in India due to the crowding out of women in agriculture and rising income levels, but the availability of alternative work opportunities reflects an increase in FLFP rate affecting total productivity, human capital, economic growth and savings and investments.

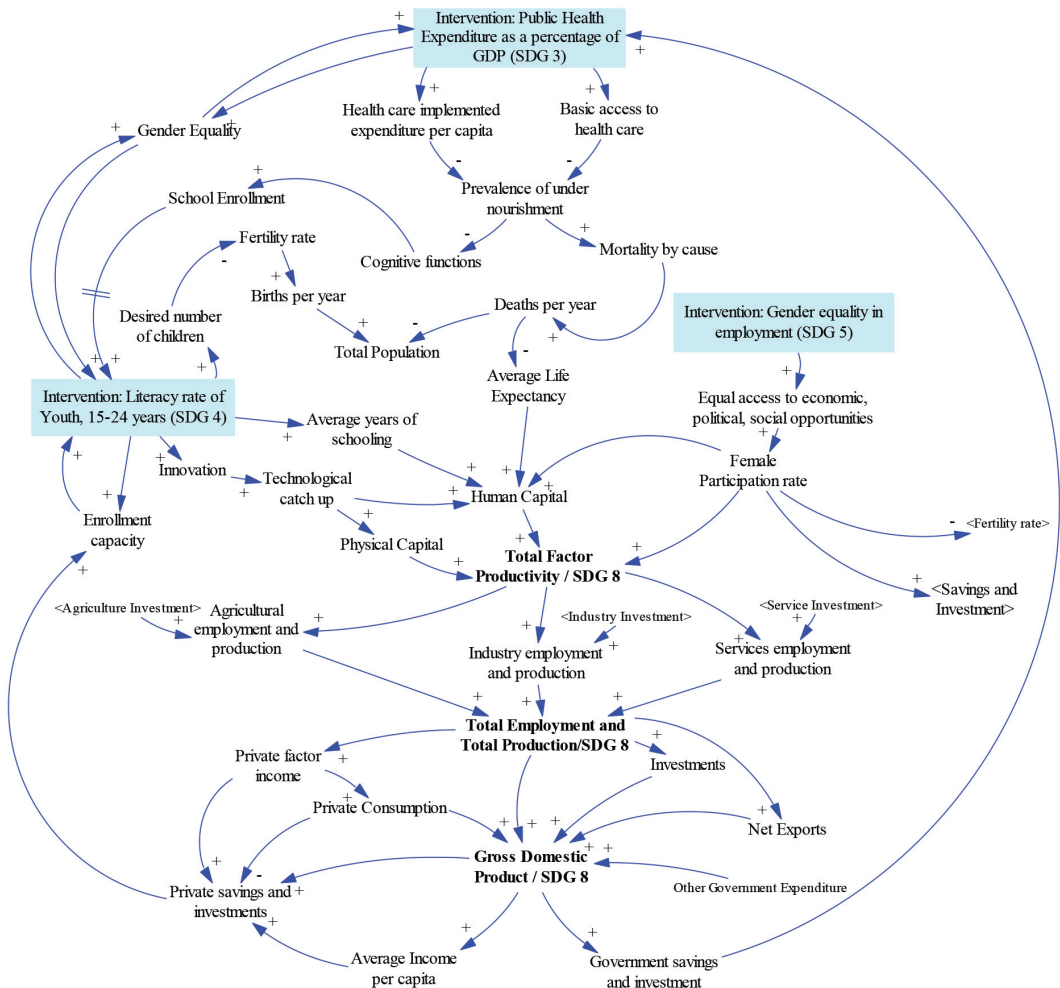


Figure 3: Causal Loop Diagram (CLD) 1. A causal relationship between the intervention policies: (a) Public expenditure as a percentage of GDP in SDG 3, (b) Literacy rate in youth, 15-24 years in SDG 4 and (c) Gender equality in employment in SDG 5 and SDG 8 targets of economic growth, employment and decent work. A + sign represents all else unchanged, a positive link polarity and a – sign represents a negative link polarity

the potential to imbibe the acceptance of gender parity as a fundamental and human right. This can channel and transform the belief systems away from social bias and gender gaps and reinforce progress on both fronts of providing quality education for all and removing all forms of gender bias against women and girls. “When girls are educated, their lives, the lives of their children, families, communities, and

countries improve” [UNESCO on Education and Gender Equality (2019-2025)]

- Health (SDG 3) and gender equality (SDG 5) are co-dependent. Without strengthening gender equality in health, the world will never be able to achieve universal health coverage in SDG 3 and never be able to end all forms of discrimination against females in SDG 5. Thus, SDG 5 is a goal that influences and is influenced by all other SDGs.

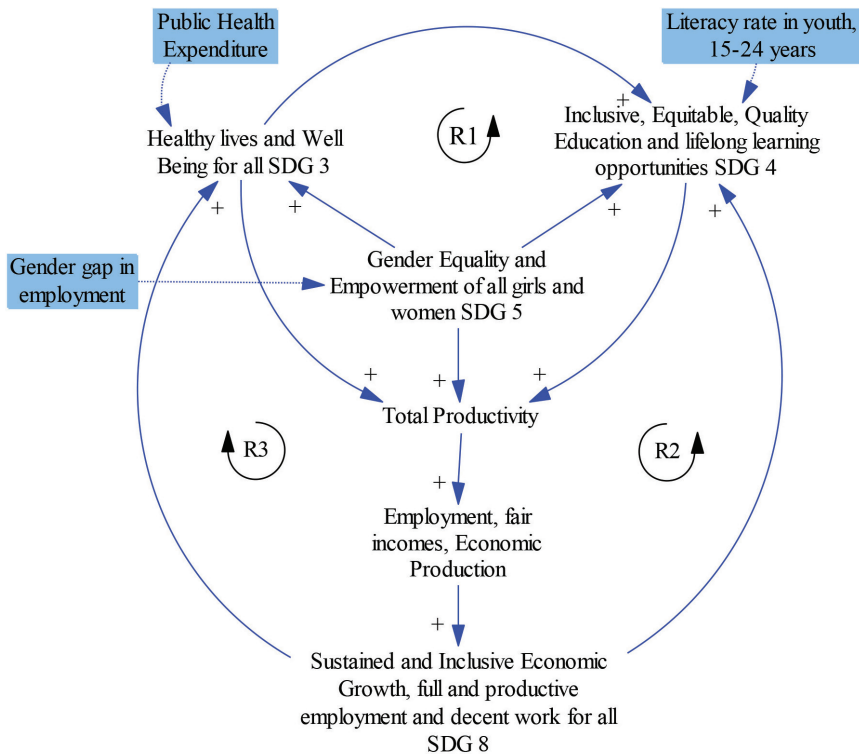


Figure 4: A simpler CLD depicting derived relationships. R1, R2 and R3 represent the reinforcing loops drawn from literature in the Indian context implying positive causal relationships

This gives us a basis for consolidating the above links confirmed from the literature in our existing framework of arguments to sketch the CLD. Figure 4 summarises our analysis of sketching the systemic view of chosen SDGs into three loops: R1, R2 and R3, where R1 can be called the health-gender equality-education reinforcing loop representing the positive causal relationships established among all three of them. R2 can be called the growth-education reinforcing loop displaying the increases in productivity brought by quality education for all and furthering effects on creating and enhancing skills, talent, and efficient human capital via investments in education possible through increased economic growth, higher per capita income, both on the part of individuals and the governments. R3 can refer to the growth-health reinforcing loop displaying growth as a means to increase government efforts to improve the

health and well-being of the citizenry. There are significant delays inherent in the feedback, which cannot be ignored, e.g., it will take many years to realise the effects of increasing investment in improving early school enrollment to affect productivity in employment and efficient human capital. This has been depicted in our CLD 1 in detail.

Extending the Effect of SDG 8 on other SDGs

In the previous section, we analysed how the interventions chosen in SDGs 3, 4 and 5 can positively impact SDG 8 via reinforcing loops. The progress in SDG 8 can set the stage for accomplishing other SDGs directly or indirectly and we map these effects on particularly three SDGs: 1 on no poverty, 12 on sustainable consumption and production and 17 on global partnerships for goals.

The sustained, inclusive and environmentally sustainable economic growth, with full and productive employment and decent work for all defined by 12 targets and 17 indicators in the global indicator framework, aims to bring ILO's decent work and UN SDG's sustained, inclusive and sustainable economic growth at the forefront for making our world more prosperous, stronger, peaceful, cleaner, and greener. As discussed, we map these effects on related SDGs, particularly SDGs 1, 12 and 17. The following arguments support our analysis:

- Progress on GDP and productivity growth is essential to reduce poverty (SDG 1) as much as it is necessary for ending hunger (SDG 2), ensuring good health and well-being for all (SDG 3), quality education (SDG 4), gender equality and empowerment (SDG 5) and peace, just and strong institutions (SDG 16). Mere total productivity growth has never realised the true potential of "trickle-down" effect of economic growth on the poor. Development and growth, when inclusive provide a basis for lifting people out of poverty, rising labour income and reducing inequalities. SDG 8's consideration of the distribution of higher incomes and higher GDPs on one hand and decent work for all on the other will help in a drive towards sustainable development and bright futures through fair income, dignity, social protection, reduced inequalities, and productive and formal employment for all. Thus, we can establish a positive causal pathway from SDG 8 to SDG 1.
- Progress on sustainable economic growth in SDG 8's target 4 rests on the assumption that to shape environmentally sustainable consumption activities and production processes, societies will promote the development of new technologies in areas such as communication, information, transportation, and production, in addition with the change in values, principles, and perspectives which can accelerate novel behavioural changes in consumers' responsibilities, businesses' activities and governments' policy decisions (International Labor Organization, 2019). Stronger economies in the form of more resources at the government's disposal through rising productivity and income levels provide opportunities for investments in R&D capacities and the implementation of environment-friendly technologies, facilitating sustainable, and efficient use of natural resources, reduction of waste generation, encouraging companies to adopt sustainable practices, promoting responsible consumption and production styles, all together develop a positive causality towards achieving SDG 12, simultaneously with SDG 2's target of sustainable agriculture, SDG 9 on sustainable industry and infrastructure, SDG 14 on sustainable use of oceans, SDG 15 on sustainable terrestrial ecosystems and consequently approaching SDG 13 on climate action.
- Progress towards sustained, inclusive, and sustainable economic growth all around requires developing and transferring environmentally safe technologies, effective capacity-building, creating decent jobs and building policies and institutions to support SDG 8. This opens doors for mutual agreement between countries to lend a helping hand for supporting national plans, enhancing international support through coordination to lead the pathway for attaining global macroeconomic stability and global efforts towards a just, sustainable and conscious development. This is a direct link between SDG 8 and 17 but this is not the end. SDG 17 particularly lays the foundations for doubling global exports, developing sustainable development measures which complement GDP and enhancing policy coherence towards sustainable development, which feeds back in the progress of SDG 8.

The above insights help us to expand our CLD from SDGs 8 to SDGs 1, 12 and 17. Incorporating these new links helps us to label a positive loop polarity from economic growth and employment towards reducing poverty, a positive loop polarity towards sustainable consumption and production patterns and a reinforcing loop, labelled as R4 representing growth-global partnership reinforcing loop, displayed in Figure 5.

Discussion

The analysis draws attention to the advantages of exploring interactions and interlinkages between SDGs using the CLD through feedback loops. Working with this tool of systems dynamics brings the possible feedback loops to the forefront of India's development plans to achieve SDGs by 2030 and beyond. The synergies we have found between SDGs 3, 4 and 5 with SDG 8 and further with SDGs 1, 12 and 17 aid integrative, coherent, and holistic thinking to implement effective policies and strategies for attaining the

goals. The construction of a CLD is not limited to the SDGs considered but can be extended to see how other SDGs affect the ones studied here. This gives us a way of sketching a systemic view of all SDGs embedded in the systems thinking approach as a systemic solution, rather piecemeal, to the multidisciplinary and complex issue of sustainable development.

Applying the interaction framework ratings developed by Nilsson *et al.* (2016), our analysis elucidates that public health expenditure as a percentage of GDP reinforces the annual growth rate of real GDP per capita (+2, one objective creates direct conditions that lead to the achievement of other objectives). Literacy rate in youth 15-24 years reinforces substantially reducing the proportion of young people not in employment, training or education (+2), as well as enables higher levels of economic productivity through diversification, technological upgradation, and innovation, including through a focus on high-value added and labour-intensive sectors (+1, the pursuit of one objective enables the achievement of another

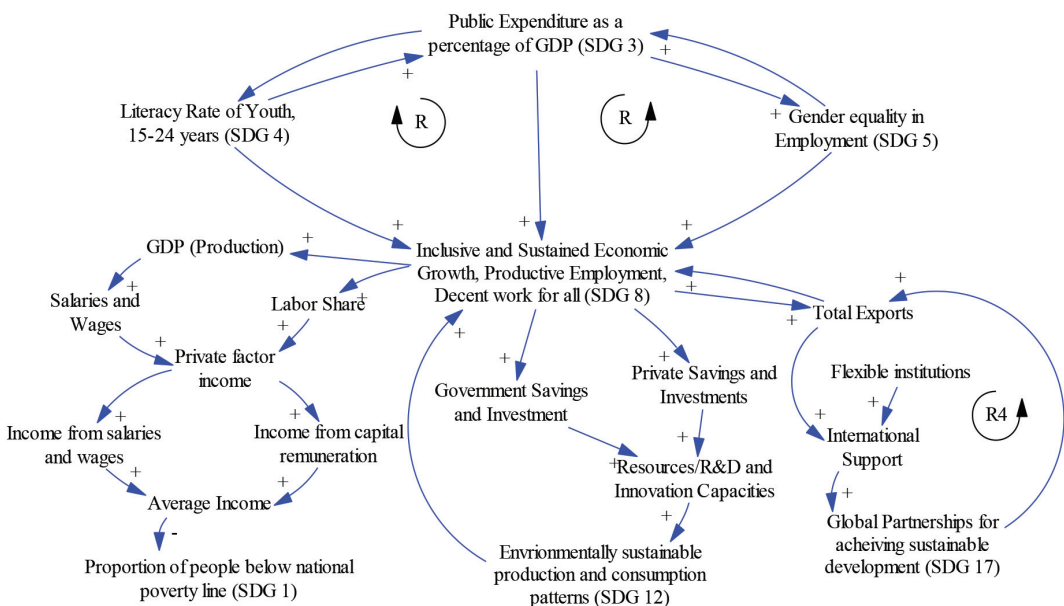


Figure 5: Causal Loop Diagram (CLD) 2. An extended causal map representing relationships between SDG 8 with SDG 1 (no poverty), SDG 12 (sustainable consumption and production patterns) and SDG 17 (global partnerships for sustainable development). R4 is the reinforcing loop initiated in the discussion between SDG 8 and 17

objective). The reduction in gender inequalities in employment enables the achievement of full and productive employment and decent work for all women and men, including the young and equal pay for work of equal value (+1). Whereas higher real GDP growth rate per capita and productive employment reinforces eradicating extreme poverty (+2), enable responsible consumption and production (+1) and finally reinforce global partnerships and international support (+2).

One central pattern or behaviour (systems archetypes) observed in our model is reinforcing growth through the reinforcing loops R1, R2, R3 and R4 (Figure 4 and Figure 5). The common pattern or behaviour for this archetype accelerates the system's performance over time. All of the four reinforcing loops mapped to SDG 8 suggest SDG 3 (through increases in public health expenditure), SDG 4 (through improvements in literacy rate of youth, 15-24 years), SDG 5 (through achieving gender parity in employment) and SDG 17 (through enhancing international support) as leverage points for India's national development plan for achieving Agenda 2030.

Formulating policies for Agenda 2030 is often expected to be highly interactive, balancing diverse objectives. Based on our analysis, a few policy recommendations for NITI Aayog are (1) Strategically identifying interlinkages and the degree of interdependency at the target/indicator level of all SDGs in a similar exercise will help to view "the bigger picture" embedded in the systems thinking approach. This is important and will help prioritise key areas as entry points for planning the sequence of actions. (2) In order to achieve a clear mapping of interdependencies, a structured participatory process is a solution at hand. Moving towards multi-stakeholder approaches in the decision-making processes will facilitate minimising errors. This will help bring together a wide range of knowledge, perspectives and values behind the implementation of SDGs. (3) Systems thinking can support the policy process's input, process and output stage with the diverse

tools at its disposal such as scenario planning, cognitive mapping, system dynamic modelling and learning labs, to name a few. Advanced tools such as iSDG model and SDG Synergies could be incorporated into policy-making stages. (4) Cross-sectoral collaborations among various ministries must deliver effective policies rather than the traditional, siloed approach. Finally, a unified strategy towards SDGs will help promote OECD's Policy Coherence for Sustainable Development (PCSD). (5) An integrated perspective towards planning, data collection, implementation, monitoring and evaluation through integrative matrices, scoring the degree of interlinkages, integrated impact assessments, and iterative decision making will help navigate the uncertainty and complexities of sustainable futures.

The main results from examining interactions between SDGs may be used in policy planning but one must be cautious of their limitations to capitalise such integrated tools in policy decisions. The reality will always be more complex, incorporating more uncertainties and unforeseen effects. Thus, our diagrams might not have included such unintended and unanticipated consequences of policies. The CLD provides the aggregate or strategic view of the structure of the problem and has advantages over earlier conceptualisations. However, they cannot distinguish between physical information links, stocks, and flows, cannot be expanded for mapping the non-linearity and may include incorrect inferences of the dynamics. The analysis still does not test the linkages quantitatively and leaves scope for future research with the availability of adequate data in India.

Conclusion

This study applies a systems approach to examine possible systemic relationships among the SDGs implementation in India. While we considered the systemic SDG linkages in the case of India, our methodology and some of our results could be applied to any national setting and can provide insights for global-level work.

Our primary and most important conclusion is confirming the reinforcing behaviour patterns among SDGs 3, 4 and 5 towards SDG 8 via causal loop mapping of one national indicator selected as intervention policies from each SDG. We have explicitly identified +2 (reinforcing) and +1 (enabling) ranking between public health expenditure, youth literacy rates and gender parity in employment with economic growth. One system archetype of reinforcing growth emerged from our analysis, indicating the three chosen national indicators as leverage points for enhancing SDG 8 targets. This further extends to developing positive causal pathways of SDG 8 with SDGs 1, 12 and 17. Such an exercise for exploring SDGs has implications for holistic, eco-friendly, sustained, inclusive, and just development.

It is thus important to consider the larger system of sustainable development and the broader effects and impacts of SDG-aligned solutions in a more holistic, systems-thinking approach. Integrated tools from the systems thinking approach can bring interlinks to the forefront. Given the specific need to reduce poverty, illiteracy, healthcare systems, unemployment, and women's participation, among others, India must plan to accomplish certain goals and targets over others. Thus, the positive causal interactions between goals and targets so considered, this study highlights key policy areas to prepare our nation for the accomplishment of its overall SDG agenda.

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