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A Bi-Annual Double-Blind Peer Reviewed (Refereed/Juried)
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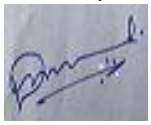
Editorial Note

CSIBER International Journal of Environment (CIJE) offers a venue where relevant interdisciplinary research, practice and case studies are recognized and evaluated. Increasingly, environmental sciences and management integrate many different scientific and professional disciplines. Thus the journal seeks to set a rigorous, credible standard for specifically interdisciplinary environmental research. CIJE is a multidisciplinary journal, publishing research on the pollution taking place in the world due to anthropogenic activities. CIJE welcomes submissions that explore environmental changes and their cause across the following disciplines like atmosphere and climate, biogeochemical dynamics, ecosystem restoration, environmental science, environmental economics & management, environmental informatics, remote sensing, environmental policy & governance, environmental systems engineering, freshwater science, interdisciplinary climate studies, land use dynamics, social-ecological urban systems, soil processes, toxicology, pollution and the environment, water and wastewater management, etc.

We invite authors to contribute original high-quality research on recent advancements and practices in Environment Management. We encourage theoretical, experimental (in the field or in the lab), and empirical contributions. The journal will continue to promote knowledge and publish outstanding quality of research so that everyone can benefit from it.

Er. D. S. Mali
Editor, CIJE



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Contents

AQUAPONICS AS AN ECOFRIENDLY METHOD, TO STUDY THE GROWTH PARAMETERS OF DIFFERENT VEGETABLES

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ABSTRACT

Aquaponics is innovative method in agriculture which combines aquaculture with hydroponic for increased production of vegetables. As compared to world's population demand food production is essential and increase aquaponics a soil less culture is the fantastic way for complete this four demand with fewer harmful effect on environment and more benefits, and a feature of a contemporary agricultural technology. a method for producing plants and aquatic animals in which waste from feeding the aquatic organisms provides the bulk (>50%) of the nutrients needed for the best possible plant growth. Aquaculture and hydroponics are combined to form the word "aquaponics." According to the Food and Agriculture Organization of the United Nations (1988), aquaculture is "the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants," whereas hydroponics is " the production of plants in a soilless medium whereby all of the nutrients supplied to the crop are dissolved in water." Despite the fact that hydroponics is a widely recognized technology, the name "aquaponics"

In aquaponics system the nitrification process involves two main kinds of nitrifying bacteria. The growth taken into account for parameters viz hight, root length, shoot length, leaf width, breadth of vegetables *Solanum lycopersicum* (tomato), *Capsicum frutescens* (chili), *solanum melongena*(brinjal),*Brassica oleraceavar.capitata* (Cabbage). The control group and the study group differed significantly, according to the study.

The primary goal of this aquaponics research is to boost the production of food crops and achieve high aquaculture yields in a single system.

Keywords: Aquaponics, Aquaculture, Hydroponics, Soil less Culture, Organic Food.

Introduction

The principle of recirculation and water reuse with high efficiency is made possible by the integration of the fish and the hydroponics plants (1) the beginning of aquaponics in 1997, James Rakocy grow beds in large scale aquaponic system. The fish waste provides and organic food source for the plants and the plants naturally filter the water for fishes. In aquaponics the effluents from the fish circulates and provide nutrients for the plants (2). Nitrogen cycle and nitrification process are connected to water flowing for plants. As a result, protein and vegetables get grown in the same system with no external fertilizers and pesticides. It contain ecosystem with higher vegetables yield per square then conventional farming and hence same concept can be implemented in rural ad agriculture system.This is understandable as the fish do not require these nutrients in the same quantities as the plants, thus it has to be supplemented in the system (3).

"A natural microbial process keeps both the fish and plants healthy and helps sustain an environment in which they both can thrive." (4)

Traditional aquaculture also causes a series of problems. First, traditional aquaculture is characterized by crude management based on the natural environment (5) The benefits of furthering aquaponics research and subsequent fish and vegetable cultivation, which provides an alternative to current monoculture, include balanced use of water, nutrients, and fertilizer. The practice of aquaponics production not only enhances water consumption efficiency but also improves efficiency of agricultural inputs through the reduction of land requirements for production. (6) These systems have the potential to employ microbial denitrification as a means of transforming nitrous oxide into nitrogen gas. This process can occur provided there is an adequate supply of carbon sources derived from waste materials. Consequently, bacteria that are heterotrophic or facultatively anaerobic are able to converting surplus NO_3- (nitrates) into N_2 (nitrogen gas) (7) and N_2O (nitrous oxide) has strong greenhouse gas properties, and the existing microbial population within enclosed aquaponics systems can effectively catalyse its transformation into N_2 (nitrogen gas). (8) The term aquaponics refers to a broad range of systems, plants, and fish that can be mixed in different ways. Costs and returns vary by kind and degree for every system. Raft or deep water culture systems, nutrient film systems, and systems based on media-filled beds are the three general types of systems, notwithstanding the variety. While the nutrient film technique (NFT), which is used in hydroponics,

is limited to specific plant kinds (such as leafy green crops) that do not have massive, heavy root systems, raft culture is usually favoured for commercial operations. The removal of solids is necessary for both raft and NFT systems. For home-based aquaponics gardening, media-filled beds are more popular and require less stocking than raft systems. (26)

Aim-

To study aquaponics as an ecofriendly method and the growth parameters of different vegetables in aquaponics. In the aquaponics study following aspect were taken into account;

Aquaponics assembly
Collection of fishes from local aquarium
Selection and cultivation of vegetables in aquaponics
Studying growth parameters of vegetables
Comparative study on soil and aquaponics cultivated vegetables.

Material and methodology:

Build aquaponics system: (11)

A fish tank attached with two plastic buckets through water pipelines. Biofilter was added into fish tank for filtration of water. The filtered water was transported to the plastic buckets which was filled with clay pebbles and soil. Pipes were used to pump the water from fish tank to grow bed. Another pipes were attached for reverse filtered water to fish tank. Aeration pump attached to fish tank to maintained oxygen. Extension board used for power supply to filtration pump and aeration pump.

Collection of fishes: The different types of fishes were collected from local aquarium shop. Fishes added to fish tank containing tap water.

Carassius auratus (Gold fish)
Cyprinus capio (Koi)
Carassius auratus (Copper gold fish)

Selection of plants: The following vegetable plants were selected and were added in plastic bucket in triplicate.

Vegetable plants:
Solanum lycopersicum (tomato)
Capsicum frutescens (chili)
Solanum melongena (brinjal)
Brassica oleraceavar.capitata (cabbage)

Study of growth parameters

Height, root length, shoot, leaf width, breadth of vegetables were measured by scale every week.

Comparative study of soil and aquaponics vegetables

Four plastic buckets were taken and make two groups, in each group two buckets were used. Two filled with pebbles and another two filled with soil for comparative study in both groups one bucket is used for control and other for test. Control labelled as “A” and test labelled as “B” as a aquaponics set up fish tank was used from which supplied fish water to test (plants) for growth. The water pump was placed in the fish tank then set the grow bed on top of the tank and in control (plants) tap water was supplied for growth. Marketly available feed was given to the fish and changed fish tank water weekly and observed the growth of plants per weeks (1- 12 weeks)

Results –

Taken efforts were finally lead to successful comparative study of plants used fish water. There were two sets of samples taken as Test and Control which shown different growth aspects on water, in test and control pebbles and soil samples were used. Two water samples were used to check the growth of plants per week. Tap water and fish water used for it. There are various factors as temperature, humidity, p^H level was checked per week.

The different tables show differences in plant growth. As below the table values five tables were given. Four table shows growth parameters of different plants where fish water used for growth (Test). As some other four table shown growth of different plants where control tank used for growth. In test one pebble sample and other soil sample were used to check difference in growth.

Table-1: Height of plants in test sets: (fishes are average of triplicate in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	5	7	9	10	12.5	15	17	18	18.5	19	20	21
Cabbage	3	4.5	6	6.5	7	8	9	11	13	15	17	19
Tomato	4	8	12	15	21	21	23	24	25	25.5	26	27
Chilli	4	5	7	10	21	15	17	20	21	25	28	32

This table shows aquaponics water effect on height of vegetables

Table-2: Height of plants in control set: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	5	6	8	10	10	15	26	16	18	19	19	19.5
Cabbage	3	4	5	5.5	6	7	7	8	9	10	11	12
Tomato	20	6	10	13	19	20	21	24	23	24	25	25
Chilli	4	4	6	9	10.5	18	13	14	26	28	29	30

This table shows tap water effect on height of vegetables

Table-3: Root length of vegetables in test sets: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	3	4	5	7	8	10	13	14	14	16	17	18
Cabbage	2	3	3	4	5	5	7	8	9	10	11	12.5
Tomato	2	4	6	7	9	10	12	14	15	16.5	17	17
Chilli	3	3	4	6	8	10	11	13	15	17	18	20

This table shows aquaponics water effect on root length of vegetables

Table-4 Root length of vegetables in control set: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	3	4	5	8	8	10	14	15	17	17.5	18	18.2
Cabbage	2	3	4	5	7	7.5	8	8.5	10	10.5	13	13
Tomato	2	4	7	7.5	10	11	12	14	15	17	17.5	17.8
Chilli	3	3	7	8	8.5	10	11	12.5	14	15	19	21

This table shows tap water effect on root length of vegetables

Table-5: Average width of vegetable (leaves) in test sets: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	2	2.5	3	4.6	5	5.2	5.8	6.2	6.5	7	7.5	8
Cabbage	3	4	6	7	9	10	12	14	16	17	18	20
Tomato	2	2.4	3	3.4	4	4.2	4.6	5	5.5	6	6.2	6.8
Chilli	1	1	1.5	1.5	1.5	2	2	2.5	2.5	3	3	3

This table shows aquaponics water effect on width of vegetables

Table-6: Average width of vegetable (leaves) in control sets: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	2	2	2.5	3	4	4.5	5	5.8	6.4	6.9	7.2	7.6
Cabbage	3	4	6	7	9	12	15	17	18	19	20	24
Tomato	2	2	2.3	3	3	3.5	3.9	4.2	4.5	4.7	5	5.6
Chilli	1	1	1.2	1.5	1.7	1.7	1.9	2	2	2.1	2.2	2.4

This table shows tap water effect on width of vegetable.

Table-7: Leaves height in test sets: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12

Brinjal	1	2	2.5	4	5.5	7	7.8	9	10	11.9	12	12.4
Cabbage	3	5.7	6.4	7.5	8.7	9.4	10	12	14	16	18	20
Tomato	2	2.2	3	3.7	4	4.4	4.7	5	5.2	5.6	5.9	6.7
Chilli	1	1.7	2.5	2.8	3.2	3.6	3.8	4	4.6	5	5	5.2

This table shows aquaponics water effect on height of leaves of vegetables

Table-8: Leaves height in control sets: (Average of triplicates in cm)

Name of plant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brinjal	1	2	2.5	3	4	4.5	6.6	8.9	10.1	11.7	11.9	12
Cabbage	3	5	6.7	8	8.8	9.6	11	13	16	18	20	22
Tomato	2	2.2	3	3.5	4	4	4.5	4.7	5	5.2	5.6	6
Chilli	1	1.5	2	2.5	2.7	3	3.5	3.7	3.9	4.1	4.5	4.7

This table shows tap water effect on height leaves of vegetables

Discussion-

In the present study height of test group vegetable is greater than control group, in root length of vegetables test group vegetables are greater result then control only cabbage shows the different result in control group, in leaves length and width cabbage show greater result in control as compare to test group. In test group brinjal, tomato, chilli shows best result.

As per the result it is concluded that aquaponic system is the best for vegetables for better growth and yield. Aquaponics is an integrated multi-trophic system that combines elements of recirculating aquaculture and hydroponics (21) this is innovative method in agriculture have two profit centres vegetables and fish (22) both have large economic value in today's market as well as in future.

However, in course of our study we focused that we have coupled aquaponic with agriculture for sustainable use of water to increased yield. As per the commercial development of socially, ecologically, and environmentally sustainable aquaponic systems confronts several technical challenges are improved nutrient solubilization and recovery for a better use of the nutrient input and reducing extra-mineral addition, e.g., phosphorus recycling, adapted pest management, reduce water consumption to a high degree by limiting the need for water exchange (23).

Varieties of crops we studied showed faster growth in aquaponic system as compare to control. We get nitrite and potassium from fish waste which used to grow plants faster than normal water. Considering normal and increasing growth of plants can be implemented regular cultivation fields for additional supplements. It can be supportive, economically viable and soil quality enhancing option for Indian agriculture.

In this study, we have coupled aquaponics with agriculture for sustainable used of fish water as test to increased yield and growth of plants and enhancing the quality of soil by keeping a normal water as a control. It was observed that there is increased plant growth with the water supplied through aquaponics than control plants.

Considering its potential, as a coupled option can be implemented in rural agriculture land for additional and sustainable benefit through developing area and land specific models. Overall, it is a sustainable, economically beneficial and coupled agriculture model for the farmers for certain locations.

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A Review on Control Measures for Various Gerbera Diseases

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Abstract
Gerbera Jamesonii is a popular and colourful flowering plant that belongs to the Asteraceae family. Gerbera flowers are prized for their striking, daisy-like appearance and vibrant colours, making them a favourite choice for floral arrangements, bouquets, and gardens. Gerbera flowers hold both aesthetic and ecological importance, making them significant in various contexts like ornamental value, economic importance, gardening and landscaping, cultural and symbolic importance. Gerbera daisies are known to attract pollinators like bees and butterflies, which are essential for maintaining healthy ecosystems and supporting biodiversity. They can be used effectively in garden beds and borders to add bright splashes of colour. Their sturdy stems and long-lasting blooms make them popular in floral arrangements. They are often used in bouquets, centrepieces, and decorative displays. The gerbera plant is susceptible to various microbial diseases. Effective management of gerbera diseases involves a combination of awareness, preventive measures, and timely interventions. In this paper we are dealing with awareness about the diseases that affect gerbera plant, identification of pathogens as well as control measures which will be helpful for hobbyist gardeners as well as commercial growers.
Keywords- Gerbera, pathogen, control measures

Introduction:
Gerbera, scientifically known as *Gerbera jamesonii*, is a popular and widely cultivated flowering plant native to South Africa. It belongs to the Asteraceae family, which includes daisies, sunflowers, and asters. Gerbera is commonly referred to as the "African daisy" or simply "gerbera daisy."
Gerbera daisies are known for their striking and colourful flowers. They typically have large, single blooms with a prominent central disk surrounded by radiating petals. There are numerous cultivars and varieties of gerbera daisies, each with its unique flower colors, sizes, and characteristics. Gerbera daisies are perennial plants in their native habitat but are often grown as annuals or treated as tender perennials in temperate climates. They thrive in well-drained soil and require plenty of sunlight to produce abundant flowers. They are also popular choices for container gardening. Gerbera daisies typically bloom during the spring and summer months, although they can flower intermittently throughout the year under suitable conditions. Gerbera daisies are highly prized in the floral industry for their vibrant colors and long vase life. They are often used in bouquets, floral arrangements, and cut flower displays.
The genus Gerbera consists of about 40 species and amongst them only one species namely *G. jamesonii* is under cultivation (6).
Gerbera has great ornamental value due to the typical capitulum inflorescence that displays a great variety of colors, and to the floral stem, which is highly valued by consumers as individual vase decorations and bouquet compositions (Mata et al., 2009). Gerbera cultivars of commercial importance throughout the world are Zingaro (red), Vista (red), Dustty (red), Fredorella (red), Silvester (white), Delphi (white), Salvadore (yellow), Rosaline (pink), Davaellen, Goliath, Cream Clementine (creamy white), Maroon Clementine (orange), Flamingo (Pale rose), Uranus (yellow), Fredenking (yellow), Terra queen (Pink), Valentine (pink), Fredaisy (pink), Labalga (lilac) etc (6).
They are versatile and adaptable plants that can brighten up gardens, homes, and celebrations with their vibrant and cheerful blooms.

Importance of Gerbera:

The first official description of the South African species Gerbera jamesonii, also known as Transvaal daisy or Barberton daisy, was made by 1.D. Hooker in 1889 in the Curtis Botanical Magazine (Penningsfeld and Forchthammer 1980). It bears a large capitulum with prominent, yellow, orange, white, pink, or various red-colored ray florets (Hansen 1985). The breeding of gerbera started at the end of the 19th century in Cambridge, England, when two South African species. *G. jamesonii* and *G. viridifolia*, were crossed by RI. Lynch. He named the hybrid *Gerbera x cantebrigiensis*, known today also as Gerbera hybrid. Today, gerbera is known as an important article of trade and it belongs to the most important ornamental plant species in the world, together with rose, chrysanthemum, carnation, and tulip. In 1991 gerbera was ranked sixth in sales through Dutch flower auctions and it is sold both as cut flowers and pot plants (3).

The flowers are hardy and stand the rigors of transportation and a long keeping quality fetches a good market price. The species, a perennial herb, is native to South Africa and Asia. It is an important commercial flower grown throughout the world in a wide range of climatic conditions. Gerberas mostly inhabit temperate and mountainous regions. In India they are distributed in the temperate Himalayas from Kashmir to Nepal at altitudes from 1,300 to 3,200 m. Gerbera belongs to the family Asteraceae and can be propagated by both sexual and asexual methods. Most of the commercially grown cultivars are propagated through vegetative means, to maintain uniformity and genetic purity (7).

Gerbera is one of the top cut flowers in Europe in demand and a major portion of it is produced in various countries, including India (3).

Gerbera plays an important environmental role in the removal of chemical fumes and toxic gases according to a study of NASA (7).

Diseases of Gerbera:

Tetranychus urticae Koch, 1836 is considered a key pest of this and other ornamental plants. Several pests are known to be resistant to one or more pesticides used in flower cultivation. (11)

Alternaria leaf spot, bacterial leaf spot, bacterial blight, botrytis blight, fusarium rot, phytopthora crown rot, powdery mildew, pythium root rot, rhizoctonia crown rot and viruses are the diseases that occur in gerbera (Gary, 1995). Crown rot, root rot, bacterial blight, fusarium, powdery mildew, botrytis, are the major diseases of gerbera and root rot, fusarium wilt, powdery mildew are found prominently and are responsible for major yield loss(7).

Whitefly, leaf miner, thrips, red mites, cyclamen mites, caterpillar and root knot nematode are the major insects found in gerbera. These insect may attack the plant in any stages; and can cause huge loss in production as well as deteriorate the plant vigour and deform the plant (7).

Gerbera daisies (Gerbera jamesonii) are popular flowering plants known for their bright and colourful blooms. Like any plant, gerbera daisies can be susceptible to various diseases, which can affect their growth and overall health. Here are some common diseases that can affect gerbera daisies:

Powdery Mildew:

Powdery mildew is a fungal disease that appears as a white, powdery substance on the leaves and stems of gerbera daisies. It can lead to reduced photosynthesis and weakened plants.

Powdery mildew is major fungal disease in gerbera and can be caused by two species, Erysiphe *cichoracearum DC.* and *Podosphaera* (*Syn. Sphaerotheca*) *fusca* (Fr.) S. Blumer (8)

For the powdery mildew, the bio fungicide products tested when applied prior to disease infection may reduce powdery mildew significantly as compared to untreated. As a consequence, these products can be used as part of an integrated disease management program as an alternative to reduce the use of standard fungicides for the control of powdery mildew in gerbera daisy (8).

Botrytis Blight (Gray Mold):

Botrytis cinerea is a fungus that causes gray mold on gerbera daisies. It typically appears as brownish-gray spots on the leaves and flowers. *Botrytis* can lead to rotting and wilting of affected plant parts.

The temperature range in which *B. cinerea* could germinate and growin vitro is 5–30 °C. In climate chamber experiments flowers had more lesions of *B. cinerea* at temperatures of 20 and 25 °C than at 10 and 15°C. At 15, 20 and 25°C the infectivity of *B. cinerea* conidia was negatively affected during a storage-period of 7 days (10). Therefore, if the flowers are maintained at 20 and 25°C gerbera can be protected from the *B. cinerea* conidia during their storage period.

Alternaria Leaf Spot:

Leaf spot diseases, caused by various fungi, can create circular or irregular spots on the leaves. These spots may be brown, black, or tan. In severe cases, the leaves may turn yellow and drop prematurely.

Alternaria leaf blight is one of the most important diseases of gerbera (*Gerbera jamesonii*) worldwide. The disease was prevalent in all the flower growing areas of Kashmir valley.

Symptoms of disease were observed on leaves and peduncles. However, lesions on peduncles were longer rather than round. The periodical observations of disease development revealed that Alternaria leaf blight in the field

appeared in early May as small brown scattered spots which gradually enlarged in size and attained maximum diameter of 23 to 26 mm within a period of 55 to 59 days. These spots frequently coalesced to cover maximum leaf area. However, sporulation was observed when spots had obtained more than 4 mm size (3).

The sypmtoms at the initial stage of the infection were brown, small, scattered spots on the leaves that gradually become round or irregular. Spots coalesce to affect large areas of leaves and cause defoliation. Affected plants showed lower vitality, suppressed development and fewer, smaller, distorted shape of flowers. Fungal isolates, obtained from infected leaf tissues were grown in pure culture and on the basis of morphological characteristics of colony and conidia, the pathogen was identified as *Alternaria alternata*. The fungus produced effuse, olivaceous black colonies with dark olive-green margins, and abundant branched septate, golden-brown mycelium. The conidiophores were branched, straight, pale brown to olive brown. The pale brown conidia of the isolates were catenated in long, sometimes branched chains of 5-12 spores. The size of conidia varied from 20-63 µm in length and 9-18 µm in width and usually ovoid to ellipsoid or obclavate with short conical beak at the tip (5).

Gerbera cut flower business is becoming more channelized as many growers came in this business. Leaf folding, pseudo flowers, twins flower, escape pitting or cracking and stalk bending are the major physiological disorders seen during the gerbera production duration (7).

Integrated pest management (IPM) is a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society, and the environment. In an IPM program, pest management is coordinated with production practices to achieve economic protection from pest damage while minimizing hazards to crops, human health, and the environment. The famers are also getting more yields of crops; more annual income and they had developed better leadership than the non-practitioners. IPM has been a widely accepted technology transfer platform for the policy makers, academicians, technicians and farmers in Nepal. The information regarding the occurrence of insect-pests and diseases on gerbera is scanty hence the present studies were undertaken to explore the prevalence of insect pests and diseases of gerbera and its management practices adopted in Kathmandu valley (7).

Root and crown rot Disease:

Root and crown rot diseases in gerbera are often caused by soil-borne pathogens, including various fungi and water molds. These diseases can lead to the decay of roots and the crown (the area where the stems meet the roots), ultimately resulting in wilting, yellowing, and death of the plant.

Farmers were using biological agents like *Trichoderma viridae* and *Pseudomonas* for the management of root rot, fusarium wilt and crown rot (7).

This is a fungal disease that affects the base of the plant, often near the soil line. It can cause dark, sunken lesions and eventually lead to the plant's collapse causes crown and stem rot.

Root rot is another fungal disease caused by overly wet soil conditions and is characterized by rotting of the plant's root system. It can lead to wilting, yellowing leaves, and eventual plant death.

Gerbera daisies are susceptible to root rot in waterlogged or poorly drained soils. Therefore should avoid soils with organic matter to improve drainage. Plant gerbera daisies should have provided with good air circulation. Crowded plants are more prone to fungal diseases. Garden must be kept free of debries and fallen leaves, as these can harbour pathogens must be removed and destroyed.

Bacterial Diseases:

Bacterial leaf spot disease on gerbera caused by Pseudomonas cichorii also is reported. The symptoms of this disease were: small to large spots, circular at first and then became irregular and dark brown to black spots. (6)

Viral Diseases:

Gerbera daisies can be susceptible to various virus diseases, including Gerbera mosaic virus and Tomato spotted wilt virus. Symptoms can include mottled or distorted leaves, stunted growth, and reduced flower production.

Plant viruses are infectious particle composed of a protein coat and a nucleic acid core. Viruses are classified by the type of nucleic acid they contain, and the shape of their protein capsule. Till date only RNA viruses are reported on gerbera, which may be of two types: single or double stranded. The single stranded RNA viruses are further divided into two, positive sense and negative sense. In gerbera mostly single stranded positive sense RNA [ss (+) RNA] viruses such as Tobacco mosaic virus (TMV), Tomato black ring virus (TBRV), Cucumber mosaic virus (CMV), Tobacco rattle virus (TRV) are reported. Contrary to that, a very few reports of single stranded negative sense RNA [ss(-)RNA] viruses are also reported in literature. The Tomato spotted wilt virus (TSWV) and Impatiens necrotic spot virus (INSV) are the tospovirus, and their genome consists of single stranded one negative and two ambisense single-stranded RNAs (6).

It was noticed that greenhouse-grown *G. jamesonii* plants were showing severe malformations of flowers and necrotic spots on the leaves.

Diseases caused by CMV in Gerbera

Cucumber Mosaic Virus is a plant pathogenic virus that affects a wide range of host plants, including gerbera daisies. This virus is known for causing mosaic-like symptoms on the leaves of infected plants.

CMV is the member of genus Cucumovirus in the family Bromoviridae. CMV infection is characterized by severe chlorotic mosaic, greening of veins on leaves, color breaking in florets accomplished with flower deformations, and poor growth of the bloom. It causes yellowing and mottling in gerbera leaves.

Diseases caused by TRV in gerbera

TRV typically refers to "Tobacco Rattle Virus." Tobacco Rattle Virus is a plant virus that affects a variety of crops, including ornamental plants like gerbera daisies. It is transmitted by soil-inhabiting nematodes, particularly the species Trichodorus and Paratrichodorus.

TRV is an important plant pathogenic virus of family Virgaviridae of genus Tobravirus. The leaves showed ring spots and light green line patterns, which in older leaves often became necrotic.

TRV is transmitted by nematodes. Managing nematode populations in the soil is crucial. Crop rotation, use of nematode-resistant plant varieties, and soil treatments are the methods to control nematode populations.

While TRV is transmitted by nematodes, other pests, can also vector the virus. Integrated pest management strategies are implemented to control vectoring insects.

Diseases caused by INSV in gerbera

INSV Impatiens Necrotic Spot Virus or Indian Peanut Clump Virus, is a plant virus that primarily affects eanut plants. It belongs to the genus Tospovirus. However, in the context of gerbera daisies, another virus with a similar acronym, INSV, refers to Impatiens Necrotic Spot Virus. Impatiens Necrotic Spot Virus is a member of the Tospovirus genus and is known to infect a wide range of plants, including gerbera daisies. INSV is easily mechanically transmissible, often causes severe damage on infected plants, and spread rapidly through insect vector (Thysanopthera).

Impatiens Necrotic Spot Virus (INSV) can cause several symptoms in gerbera plants. Some common symptoms associated with INSV infection include:

Ring Spots: Circular or ring-like patterns of discoloration on leaves.

Necrosis: Necrotic (dead) areas on leaves, often appearing as brown or black lesions.

Leaf Curling: Infected leaves may exhibit curling or distortion.

Stunting: Reduced growth and stunted plant development.

Yellowing: Yellowing of leaves, which may resemble nutrient deficiencies.

Mosaic Patterns: Mottled or mosaic patterns on leaves.

Management of viral diseases in gerbera

Management of viral diseases is much more difficult than that of diseases caused by other pathogens because the viral diseases have a complex disease cycle, efficient vector transmission and no effective virucides available. Integration of various approaches like the avoidance of sources of infection, control of vectors, cultural practices (conventional) and use of resistant host plants (non-conventional) have been used for the management of diseases caused by plant viruses (6).

By Cultural Practices:

Prevention is the key for managing the viral diseases because virus-infected plants cannot be cured. If viral infection is suspected in gerbera plants, samples should be sent to testing facilities to confirm the presence of the virus. Once the disease has been identified, the only management option is to discard infected plants (Whipker, 2014). However, managing the vector of the virus, the spread of western flower thrips can be minimized. This can be done using strategies to physically exclude the pests such as installing fine mesh screens (mesh size < 135 nm) on external openings to prevent entry of thrips vectors into the greenhouse. Monitoring using indicator plants, such as petunia, or sticky cards can be helpful to provide early warnings of the presence of *F. occidentalis* (Allen and Matteoni, 1991). It is worthwhile to mention that western flower thrips can acquire virus at larval stage and it can transmit the TSWV and if we prevent adults from developing, transmission of the virus may be prevented (6).

By Sanitation:

It is well known fact that sanitation of the cultivation fields reduces infection and enhances crop production by many folds.

All plant debris as well as weeds and flowering plants growing nearby production areas must be removed as these can be sources of new infections and infestations. It was suggested that soil sterilization can also eliminate the developmental stages of vector species (6).

By Biological Controls:

Thrips are tiny, slender insects belonging to the order Thysanoptera. They are pests in agriculture and horticulture, as they can damage crops by feeding on plant tissues and transmitting plant viruses. There are many species of thrips, and they can be difficult to control once they infest a plant.

Biological controls can be effective for controlling of insect species when their populations are low. Some predator species have been identified for control of western flower thrips. These are *Euseius stipulatus*, *Metaseiulus occidentalis* (Nesbitt), *Amblyseius andersoni* (Chant), *Amblyseius scutalis* (Athias-Henriot), and *Amblyseius* (Euseius) *tularensis* (Congdon).

Lady beetles (Coleoptera: Coccinellidae), ladybugs, or ladybird beetles are among the most visible and best known beneficial predatory insects (6).

By Use of Virus-Free Gerbera Planting Material

Viruses spread from mother plant to their progenies through planting of infected cuttings, tubers and other vegetative plant materials that have great possibility of virus transmission. Consequently, population of plants may become infected by the virus if not protected timely and hence reliable early diagnosis of viruses is essential for designing their efficient disease management. Use of virus-free planting material and their transplantation in greenhouses has been suggested for better crop production (6).

General Precautions

The problem of Leaf folding can be prevented by ensuring consistent and adequate humidity levels in the greenhouse or growing area to prevent excessive transpiration, which can lead to leaf folding.

Appropriate support must be provided to the gerbera stems to prevent bending. Stake plants as needed to ensure upright growth. Also, during the storage should be kept in good condition.

There's a need to keep detailed records of growing practices, environmental conditions, and any observed disorders.

Conclusion:

There are many pathogens that can affect the growth of the gerbera plant such as Insect-pest, fungi, bacteria and viruses. Control of these insects and viruses can help good growth of the plant.

The various diseases that can harm the gerbera plant are reviewed with the possible identification and solutions to it. This can help the growers to identify the diseases and know more about the cause of the disease. It can make more awareness about the disease and its prevention.

The general precautions, sanitation and hygiene are important to the plant, with well-maintained conditions in the polyhouse to protect the plant.

The information compiled will be helpful for gerbera hobbyist gardeners as well as commercial growers, which will ultimately improve the financial and social standing of farmers who are involved in the gerbera industry. Additionally, a strategy for managing diseases has been proposed, such as biological control of virus-transmitting vectors in nature, regular monitoring and prompt action can help keep gerbera daisies healthy and free from diseases.

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Removal of Hexavalent Chromium from Industrial Waste by using Iron Nanoparticles

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Abstract

In recent decades one of the most significant areas of research has been the recycling and removal of toxic chemicals and heavy metals from industrial waste recognized as a sustainable and cost-effective strategy among hazardous heavy metals hexavalent chromium stands out as a genotoxic and carcinogenic by-product of various manufacturing activities often released into the environment in harmful concentrations. Globally chromium exists in two forms trivalent chromium which is natural and essential for metabolism and hexavalent chromium which is highly toxic and poses serious health risks including lung cancer hexavalent chromium is commonly used in industries like electroplating tanning dyeing and coating and research indicates it can be very harmful to human health consequently researchers have focused on remediation techniques for removal of hexavalent chromium. In this context, we have chosen synthesized iron nanoparticles produced through the co-precipitation method which have been characterized by their heat sensitivity up to 60^0C, pH stability between 2 and 10 and spectrometric absorption properties making them suitable adsorbents for hexavalent chromium removal from industrial effluents. The reduction of chromium levels was verified using UV-spectrometry before and after the addition of synthesized iron nanoparticles. our observations indicated that the addition of iron nanoparticles to industrial wastewater containing chromium resulted in a noticeable reduction in colour and an increase in absorption time and a rise in UV absorption levels in the future this method will be considered for chromium (VI) remediation.

Keywords: Hexavalent Chromium, Iron Nanoparticles, Chromium Remediation

Introduction:

Heavy metals contamination in water is a significant factor contributing to global health and environmental issues. Industrial discharges and sewage sludge introduce various pollutants into water bodies, subsequently infiltrating rivers and contaminating groundwater and drinking supplies. The presence of these HMs has exacerbated water pollution problems, leading to detrimental effects on both the economy and public health (**Irshad *et al.*, 2023; Singla, 2022; Kowalik *et al.*, 2021; Irshad *et al.*, 2021; Ahmad *et al.*, 2021**). Among these, chromium (Cr) stands out as one of the most dangerous metals, entering the environment from various natural and anthropogenic sources, thereby posing threats to all forms of life, including humans. Consumption of water contaminated with chromium can lead to serious health issues affecting the cardiovascular and urinary systems, as well as causing bone deformities, hypertension, infertility, and emphysema (**Shaari *et al.*, 2022; Haider *et al.*, 2021; Burakov *et al.*, 2018**).

The rapid pace of industrialization has led to a concerning increase in the levels of this toxic metal in our environment. The growing demand for clean water, coupled with its natural composition and the environmental repercussions stemming from inadequate safety measures and public regulations regarding industrial waste discharge, poses a significant risk of future water scarcity. Consequently, there is a pressing need for more effective and cost-efficient wastewater treatment methods to supplant traditional approaches (**Masood *et al.*, 2021; Vikrant *et al.*, 2019**). The management and removal of chromium (Cr) from wastewater represent critical environmental challenges for researchers, policymakers, and manufacturers, given the serious threats it poses to ecosystems (**Othmani *et al.*, 2022; Borah *et al.*, 2018**). Various conventional techniques have been employed in wastewater treatment facilities to address the issue of chromium contamination; however, these methods often fall short, as wastewater typically requires additional processing before disposal. Thus, identifying and assessing effective sorbents for chromium removal has become a significant challenge. Numerous nanomaterials have been developed as highly efficient, cost-effective, and environmentally friendly adsorbents for chromium extraction from wastewater. These nanomaterials offer distinct advantages over traditional sorbents, such as activated carbon and zeolite, due to their unique physicochemical properties, which include a high specific surface area, reduced diffusion pathways, and customizable active surface sites that enhance their sorption capabilities.

This study provides a comprehensive analysis of the efficient removal of chromium (Cr) from wastewater utilizing nanomaterials. It explores the significance of nanotechnology in tackling wastewater contaminated with Cr. Unlike conventional methods, this article presents a thorough examination of the advantages, challenges, opportunities, and limitations related to the application of nanomaterials for chromium removal. The primary objective is to offer an extensive overview of the existing literature on Cr removal and recovery, emphasizing the detrimental environmental impacts of Cr pollution and the interactions of Cr adsorption with various

nanomaterials. This study aims to deepen the understanding of environmental professionals regarding the potential of nanomaterials and their relevance in research from laboratory to pilot scale. It serves as a valuable resource for researchers and practitioners interested in exploring nanotechnology-based strategies for effective and sustainable remediation of Cr, while also taking into account the broader environmental implications.

Materials and Methods

Materials

Iron (II) chloride, $FeCl_2.4H_2O$ and iron (III) chloride, $FeCl_3$ were purchased from Sigma-Aldrich Company Thermo Fisher Scientific supplied Sulphuric acid (H_2SO_4) and sodium hydroxide (NaOH).

Synthesis of Iron Nanoparticles:

In this experiment, Fe_2O_3 nanoparticles were produced through the co-precipitation method. Specifically, 0.7954 g of iron (II) chloride, $FeCl_2.4H_2O$, and 1.2974 g of iron (III) chloride, $FeCl_3$, were dissolved in distilled water. The mole ratio of iron (II) chloride to iron (III) chloride was consistently maintained at 1:2 during the entire process. The resulting solution was stirred for 30 minutes on a hot plate with a magnetic stirrer. Throughout the mixing, various parameters, including temperature, pH, and stirring rates, were carefully adjusted. Following this, the mixed solution underwent centrifugation at 4000 rpm for 15 minutes to isolate the precipitate. The obtained precipitate was then dried in an oven at 100 °C for 24 hours. Finally, the dried dark brown precipitate was collected and finely powdered using a pestle and mortar. **(Hui and Salimi, 2020).**

Adsorption of Cr (VI) removal

During this experiment, Cr (VI) removal was performed in a 250 mL beaker with a magnetic stirrer frequency of 400 rpm. Each beaker contained 0.01 g crude nanoparticles and 100 mL Cr (VI) wastewater containing approximately 1gm/L concentration collected from industrial waste. Various operational parameters were examined, such as the dosage of the adsorbent (ranging from 0.2 to 1 g/L), pH levels (from 2 to 10), and contact durations (from 5 to 60 minutes). 2 mL solution was sampled and filtered through a 0.22 μm syringe filter. The concentrations of Cr (VI) in the solutions were determined using the absorbance of Cr (VI) was measured on a UV–vis spectrometer (UV- spectrometer, Bioera, Pune, India). **(Hui and Salimi, 2020) and (Saranya *et.al.* 2017)**

Particle Characterization Technique:

The Fe_2O_3 nanoparticles produced under various processing conditions can be thoroughly analyzed regarding their functional groups, phase composition, crystallite size, and morphological structure. This analysis can be conducted using Fourier Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD), and Scanning Electron Microscopy (SEM), respectively. **(Hui and Salimi, 2020).**

Results and Discussion:

Characterization of Iron Nanoparticles by UV–Vis Spectral Analysis:

According to the literature, the solution's colour changed during nanoparticle formation. We notice the colour change after the addition of iron solution indicates the formation of nanoparticles (**Abdelfatah *et al.* 2021**). The synthesized nanoparticles absorption spectra, with an intense peak at 275 nm confirm the production of Iron nanoparticles. The zero-valent iron state was assigned a peak range of 250 - 290 nm, which is entirely consistent with the outcomes of other studies (**Desalegn *et al.* 2019; Naveed *et al.* 2023**).

Figure 1. Synthesized Iron Nanoparticles

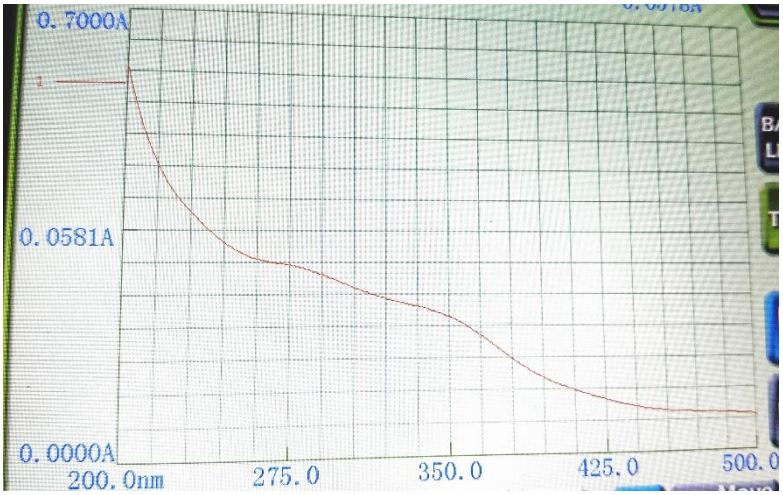


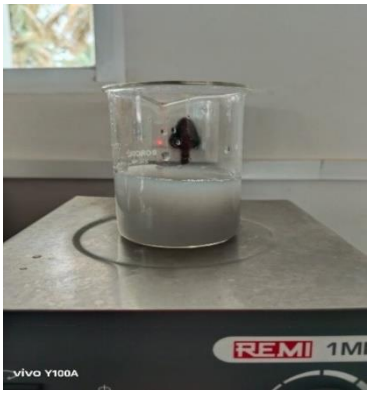
Figure 2. UV-Visible Spectra of synthesized nanoparticles

Effect of pH on Cr (VI) Adsorption:

In our study, we examined the effectiveness of Cr (VI) adsorption across various pH levels ranging from 2 to 10, employing HCl (0.1N) and NaOH (0.1N) for pH adjustments. We combined 10 mg of iron nanoparticles with 50 mL of a 10 mg/L Cr (VI) solution and allowed the mixture to stir for 60 minutes at room temperature. Our results demonstrate that the adsorption capacities for Cr (VI) remain fairly consistent from acidic pH 2 to 6. However, a notable change in adsorption capacity is observed when the pH exceeds 6. This alteration is linked to the ionization of the iron nanoparticles' surface as the pH shifts from acidic to alkaline, which impacts the electrostatic interactions between the adsorbates and adsorbents (**WooáLee and BináKim 2011; Zou *et al.* 2016**). Existing literature emphasizes the importance of maintaining an optimal pH for iron nanoparticles, as acidic conditions can increase iron corrosion. In contrast, alkaline conditions may hinder reactive sites, promoting iron precipitation. Our study indicates that the pH significantly affects the removal of Cr (VI) by iron nanoparticles, resulting in the reduction of Cr (VI) to Cr (III) at alkaline pH (**Djellabi *et al.* 2017; Xu *et al.* 2021)**. Additionally, it is noteworthy that the industrial wastewater sample analyzed contains chromium and other pollutants, which can alter the pH from acidic to alkaline during the Cr (VI) adsorption process.

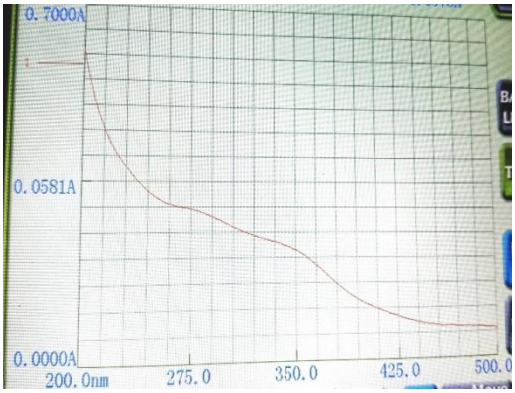
Effect of Temperature on Cr (VI) Adsorption:

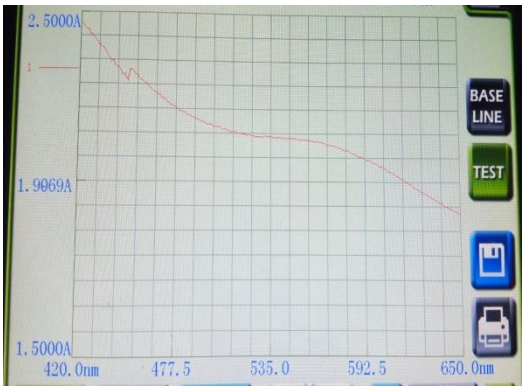
To determine the optimal processing temperature, we explored a range from 40 ºC to 60 ºC, while the stirring rates varied between 450 rpm and 600 rpm. Our findings indicate that a temperature of 50 ºC is most effective for Cr (VI) adsorption. Additionally, the stirring rate is a crucial factor, with maximum absorption observed at 460 rpm. Conversely, as the stirring rate increases, the absorption tends to decrease. This phenomenon can be attributed to the high level of agitation, which introduces significant energy into the suspension medium, leading to the dispersion of the solution into smaller precipitates. Consequently, the stirring rate influences both nucleation and aggregation, ultimately affecting particle size. (**Yusoff *et.al* 2018**, **Prabu *et.al.* 2006**, **Li *et.al.* 2006**).



A. **B.**

Figure 3. A. Initial colour of Industrial wastewater and 3.B. After remediation colour change.





A. **B.**

Figure 4.A.UV Spectra of industrial wastewater before the remediation process **4.B. UV Spectra after 20 mins during the process**

The data is presented in Figure 4. A indicates that the collected industrial wastewater containing Cr (VI) exhibits a prominent peak in the range of 275 to 350 nm, confirming the presence of Cr (VI) in its natural state. This observation closely aligns with the standard peak value associated with Cr (VI). In Figure 4. B, it is illustrated that Cr (VI) gradually reduces to Cr (III), with a peak detected between 420 and 477 nm. This finding suggests that a reduction of chromium has taken place during the remediation process. Additionally, the colour of the Cr (VI) solution changed from sky blue to grey upon treatment with synthesized iron nanoparticles, signifying the successful conversion of Cr (VI) to Cr (III). The Particle Characterization by SEM and XRD analysis were under process which gives complete characterization.

The interaction time of iron nanoparticles with Cr (VI) ranges from 2 min. to 60. We noticed that the time increases the absorption also increases.

Conclusion:

The study finds that synthesized iron nanoparticles effectively and sustainably remove Cr (VI) from industrial wastewater. Their characteristics depend on factors like pH, temperature, stirring, and contact time. Further research is needed to determine the exact remediation rate. Particle size and shape are influenced by optimal temperature and pH. This approach supports Cr (VI) remediation and aligns with circular economy principles. Future studies will aim to improve the performance and long-term stability of iron nanoparticles in real wastewater conditions for Cr (VI) and other pollutants.

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EMPLOYEE ENGAGEMENT ENHANCEMENT BY PRIDE AWARD- A CASE STUDY

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Abstract

According to Gallup's employee engagement statistics, employee recognition was most important to 37% of employees. Teams scoring in the top 20% of engagement experience 59% fewer turnovers. Approximately 34% of workers feel engaged. Employee engagement is a critical factor in the construction industry's pursuit of efficiency and excellence. This abstract investigates the relationship between employee engagement and awards within the construction sector. It examines how recognition through awards impacts employee motivation, job satisfaction, and overall engagement levels. The abstract delves into the potential benefits of utilizing awards as a tool to enhance engagement, including improved morale, increased productivity, and strengthened organizational loyalty. Through an analysis of industry-specific case study and relevant research, this abstract shed light on the strategies construction companies can adopt to effectively incorporate awards into their employee engagement initiatives. Furthermore, it explores the role of transparent evaluation criteria, fair distribution of awards, and the alignment of recognition with company values in fostering a culture of engagement and continuous improvement within construction organizations.

Keywords: Engagement, Enhancement,Employee, Construction Industry.

Introduction

Employee engagement in the context of the construction industry is a multifaceted concept that influences the performance, productivity, and overall success of construction projects. It refers to the emotional commitment and connection employees have with their work, their organization, and the goals they are striving to achieve. Engaged employees are more likely to be dedicated, motivated, and satisfied in their roles, leading to higher levels of job performance and better organizational outcomes.

Research in the construction industry has highlighted the importance of employee engagement in various areas. One study by Ashok Kadam and Uday Waghe examined the impact of employee engagement on project performance in the Indian construction sector. The study found that engaged employees demonstrated a higher level of commitment to project goals, resulting in improved project outcomes and enhanced productivity (International Journal of Scientific Research and Review, 2018).

Effective leadership plays a crucial role in fostering employee engagement in construction. Engaged leaders who communicate a clear vision and involve employees in decision-making processes create a sense of ownership and empowerment among the workforce. According to research conducted by Chitra Ranganathan and Chandrasekar Rajendran, transformational leadership positively influences employee engagement in the construction industry, leading to increased job satisfaction and reduced turnover intentions among employees (International Journal of Productivity and Performance Management, 2020).

Construction companies can promote engagement by providing opportunities for skill development and career advancement. A study by Daniel S. Halverson and Charles J. Fiss focused on the relationship between skill development, employee engagement, and job performance in the construction industry. The research found that investing in employees' skills and knowledge positively impacted their engagement levels and, in turn, led to higher job performance (Journal of Construction Engineering and Management, 2018).

Safety is a critical concern in the construction industry, and employee engagement plays a significant role in maintaining a safe work environment. Engaged employees are more likely to follow safety protocols, proactively identify potential hazards, and prioritize the well-being of their colleagues. Research by Jochen P. Zitzmann and Michael A. Niedzwecki explored the link between employee engagement and safety performance in the construction industry. The study concluded that engaged workers are more safety-conscious and contribute to a safer work environment, reducing accidents and injuries (International Journal of Construction Management, 2016).

Effective communication is another crucial aspect of employee engagement in construction. Research by Oluwole Alfred Olatunji and Olubukola Idowu Adebayo investigated the impact of communication on employee engagement and found a positive correlation between effective communication and engagement levels in the Nigerian construction industry. Open and transparent communication channels foster a sense of belonging, trust, and collaboration among employees, contributing to higher engagement (African Journal of Science, Technology, Innovation, and Development, 2018).

The construction industry often faces challenges in achieving work-life balance due to demanding project schedules. However, companies that prioritize work-life balance initiatives can significantly impact employee engagement. A study by Catherine P. Biron and Vicki M. Corbit examined the relationship between work-life balance and employee engagement in the construction industry. The research emphasized that companies promoting work-life balance initiatives experience higher levels of employee engagement and reduced turnover rates (Journal of Construction Engineering and Management, 2017).

To foster a sense of community and teamwork, construction companies can organize team-building activities and social events outside of work. Research by Bryan Christiansen and Michael B. Smith analysed the role of team-building activities in enhancing employee engagement in the construction industry. The study highlighted that team-building initiatives contribute to increased job satisfaction, collaboration, and engagement among construction workers (Journal of Management in Engineering, 2017).

Incorporating technology and innovation can also impact employee engagement positively. Research by Hisham Alkhaldi and Peter Love investigated the relationship between technology adoption, employee engagement, and job satisfaction in the construction industry. The study concluded that the integration of advanced technology improved efficiency, job satisfaction, and engagement levels among construction workers (Journal of Management in Engineering, 2019).

Awards and recognition programs play a significant role in enhancing employee engagement in the construction sector. These programs acknowledge and celebrate the contributions and achievements of construction workers, motivating them to perform at their best and fostering a positive work environment. In this industry, where physical labour and skill are vital, awards can have a profound impact on morale, job satisfaction, and overall project success.

Employee engagement has become a crucial aspect of workforce management, especially in the construction sector, where skilled labour and dedication are essential for successful project outcomes. In recent years, organizations in the construction industry have recognized the significance of employee engagement and the positive impact it can have on productivity, safety, and overall job satisfaction. This review of literature explores the role of awards and recognition programs in fostering employee engagement within the construction sector.

Boosting Morale and Motivation: Several studies have emphasized the positive impact of awards and recognition programs on employee morale and motivation in the construction industry. A study by Love grove and Fisher (2018) found that recognition programs significantly boost employee motivation, leading to improved job performance and satisfaction. Awards acknowledge employees' efforts and dedication, making them feel valued and appreciated, which, in turn, motivates them to excel in their roles.

Reinforcing Desired Behaviour: Recognition programs can be strategically designed to reinforce desired behaviours and values within the construction sector. By acknowledging individuals or teams for adhering to safety protocols, displaying high-quality workmanship, or demonstrating effective collaboration, organizations can promote a culture of excellence and adherence to best practices. This was highlighted in a study by Motet and Pfiester (2017), who found that recognition initiatives positively influenced employee perceptions of organizational values and norms.

Enhancing Team Dynamics and Collaboration: Awards that celebrate team achievements can have a significant impact on team dynamics and collaboration within construction companies. By recognizing successful project outcomes achieved through effective teamwork, organizations encourage a sense of camaraderie and cooperation among employees. This aspect of awards was examined by Christiansen and Smith (2017), who reported that team-building initiatives contributed to increased job satisfaction, collaboration, and engagement among construction workers.

Improving Retention and Reducing Turnover: Employee engagement is closely linked to employee retention, and awards and recognition programs play a vital role in this aspect. When employees feel recognized and rewarded for their contributions, they are more likely to remain committed to the organization. Cherian and

Ukizintambara (2016) found that recognition programs positively impacted employee retention rates in the construction industry.

Fostering a Culture of Appreciation: Awards and recognition programs contribute to fostering a culture of appreciation and recognition within construction companies. When employees witness their colleagues being acknowledged for their efforts, they perceive the organization as one that values and appreciates its workforce. Olatunji and Adebayo (2018) examined the relationship between communication, recognition, and engagement in the Nigerian construction industry, and they found that effective recognition positively influenced employee engagement levels.

Strengthening Employer Brand: An effective awards and recognition program can significantly contribute to a positive employer brand in the construction sector. Organizations that prioritize employee engagement and recognition are seen as desirable employers, attracting skilled professionals and top talent. This aspect of awards was studied by Alkhaldi and Love (2019), who reported that technology adoption and recognition programs improved employee satisfaction and engagement levels in the construction industry.

Providing Career Development Opportunities: Awards and recognition can be linked to career development opportunities within the construction sector. For example, companies can offer promotions, raises, or additional training as part of the recognition package. Such initiatives not only motivate the recognized employees but also encourage others to strive for similar accomplishments, contributing to overall professional growth within the organization. Halverson and Fiss (2018) explored the relationship between skill development, employee engagement, and job performance in the construction industry and found that investing in employee skills positively impacted engagement levels.

The reviewed literature highlights the significance of awards and recognition programs in fostering employee engagement within the construction sector. By boosting morale and motivation, reinforcing desired behavior, enhancing team dynamics and collaboration, improving retention rates, fostering a culture of appreciation, strengthening the employer brand, and providing career development opportunities, awards play a crucial role in creating a motivated and dedicated workforce. Construction companies that invest in meaningful recognition initiatives can expect to see improved performance, higher job satisfaction, and increased overall project success. Employee engagement is a crucial factor in the success of the construction industry. Effective leadership, skill development, safety measures, communication, work-life balance initiatives, team-building activities, and technology adoption all contribute to fostering a highly engaged and motivated workforce. By prioritizing employee engagement, construction companies can improve performance, productivity, and overall project outcomes, ultimately contributing to the industry's growth and sustainability.

About The Case-

Employee engagement is a process of aligning the employees/team members with the corporate objective physically, intellectually and emotionally. 3 S- Say, stay, and strive and 3 indicators of employee engagement when the employee says good things about the company, stays with the company for a long period and strives to achieve the objective with best efforts.

In addition to higher salary, costs incentives, promotions, etc. there and several ways to enhance employee engagement in the organization. Recognising and rewarding the employee on a periodic basis say monthly/weekly/quarterly based on the performance is a very effective way to increase the emotional attachment of the employee. PRIDE is a step in this direction, practiced successfully in one of the major Industrial Project sites with visible positive results in a short span of time, whereas PRIDE stands for Personal Responsibility In Delivering Excellence.

THE PROJECT- ALFA PROJECT LTD was implementing a major Fertilizer- Ammonia/ Urea Project from Natural Gas. The overall project cost was 8000 crore INR and EPC (Engineering Procurement and Construction) cost was 5000 crore INR. APL deployed 250 managers, Engineers, and supervisors and around 3500 workers in the peak of the projects with average worker's supervisor ratio at 15:1. Out of 250 team members, 20% belong to functions (40 members) like admin, accounts, finance, HR and IR, security and balance and 210 are engaged in line functions. Out of 250 employees 30% are in permanent roles of the company and the balance 70% are in the Project role specifically recruited for the project and at the end of the project they are terminated or transferred to another project depending on the availability.

The project had a tight schedule of 36 months and 4 months commissioning, trial run and production. The construction alternatives were done 24 X 7 basis with 2 shifts per day of 12 hours duration. Even every Sunday/

public holidays used to be a working day with 50% staff coming on alternative Sundays. More than 70% of staff used to stay without family in company provided accommodation away from their family.

The award:
The award was introduced after 40% deployment of manpower and other resources. As the name suggests the person must demonstrate a personal responsibility in delivering the tangible results with which can be termed as excellence.
Senior management staff like General Manager, Deputy General Manager and Department Heads are excluded from the award scheme. The periodicity of the awards was monthly and by 25th of every month, the names were to be proposed by respective managers to the Award Selection Committee headed by HR managers and 2 other members. The final selection is done by committee and site head on the last day of the month. The award was given in a weekly meeting consisting of all Heads of Departments, HR and all line and staff heads. The Department Head/ HR head used to declare the name of the awardee and reason for his selection. The award mostly consisted of an appreciation letter, certificate, a small cash award, or a book, etc. A huge round of applause by all the team members was a great motivation and appreciation for all the workers. At the end of the award the receiver used to share his feelings.

The feedback and Impact:
In most of the cases the receiver of the award was surprised and expressed their happiness. Sometimes they had tears in their eyes and were overwhelmed because they received the award for the first time in their lives and for the very first time people clapped for them. *Practically a competition was indulged at the field level to deliver excellent results and achieve the result. In many cases they worked out many innovative methods to achieve higher progress, reduce wastage, cost savings, etc.
*They shared this award with their family members with a sense of pride and belongingness.

The result:
Alfa project Ltd. completed the project on time with excellent quality and lower cost. Today it is a benchmark for all other Fertilizer Plants in the country delivering Urea to the famous nearby farmers of the state of West Bengal, Odisha, Jharkhand, and Bihar. The management is generating good revenue and operating margin. All the project employees and workers of the project feel proud about their role, responsibilities and association with the project with pride and high self-esteem.

Implications: Alfa Project Ltd
Employee engagement is a critical aspect of organizational success. Engaged employees are more productive, innovative, and committed to their organizations. To foster employee engagement, many companies implement various strategies, one of which is the Pride Award. This case study explores the implications of using the Pride Award as a tool for enhancing employee engagement within an organization.
Employee engagement is multifaceted and involves a combination of an employee's emotional commitment, satisfaction, and motivation. It is influenced by various factors, including leadership, work environment, job roles, and organizational culture. Effective employee engagement initiatives are designed to positively impact these factors.
Pride Awards are a recognition mechanism that focuses on celebrating employees' accomplishments, no matter how big or small. These awards can take various forms, including monetary incentives, public acknowledgment, or symbolic trophies. The central idea behind Pride Awards is to motivate employees by making them feel valued and appreciated for their hard work.
To illustrate the implications of Pride Awards on employee engagement, let's consider the case of THE PROJECT-Alfa project Ltd. that introduced Pride Awards to acknowledge and reward exceptional employee performance.
Within a year of implementation, several significant changes were observed:

- **Increased Employee Satisfaction:** Employees who receive Pride Awards often report higher job satisfaction. Knowing that their hard work is acknowledged and rewarded can make employees feel more content with their roles and the organization. Employee satisfaction scores saw a noticeable uptick. Employees reported feeling more valued and motivated, leading to an overall improved workplace atmosphere.

- **Retention Improvement:** Engaged employees are more likely to stay with the organization for a longer time. The implementation of Pride Awards can reduce turnover rates and increase employee loyalty. The company's employee turnover rate decreased by 15% over the course of the year. Employees who received Pride Awards were less likely to leave the organization.

- **Boosted Productivity:** Engaged employees tend to be more productive. The motivation and satisfaction stemming from Pride Awards can lead to improved job performance, benefiting both the employee and the organization.
- The productivity of teams and departments with recognized employees experienced a 10% increase in output. This translated to higher profits for the company.

- **Enhanced Team Collaboration:** Pride Award recipients often acted as role models within their teams, promoting collaboration and knowledge sharing. It can also positively impact team dynamics. Recognized employees tend to feel more connected to their colleagues and become a source of inspiration and motivation for their peers.

- **Talent Attraction:** Organizations known for recognizing and rewarding their employees tend to attract top talent. Prospective employees are more likely to be drawn to organizations with a strong commitment to employee engagement.
- Alfa project Ltd. observed a rise in job applications from highly skilled professionals. The company's reputation as an employer that appreciates and rewards its employees helped attract top talent.

- **Increased Motivation:** Pride Awards serve as a motivation booster. When employees receive recognition for their efforts, they are more likely to feel motivated to continue giving their best. This motivation can result in increased productivity and higher levels of job satisfaction.

- **Positive Organizational Culture:** The implementation of Pride Awards fosters a culture of recognition and appreciation within the organization. This culture shift can improve employee morale and create a positive work environment, making employees more engaged.

- **Alignment with Organizational Goals:** Employees who are recognized through Pride Awards often feel more aligned with the organization's goals. This alignment can lead to a more unified and focused workforce.

Conclusion

Implementing Pride Awards can have significant implications for enhancing employee engagement within an organization. This case study showcases the positive outcomes seen in Alfa project Ltd. and highlights the potential benefits of recognizing and rewarding employees for their contributions. When employees feel valued, motivated, and engaged, organizations stand to gain in terms of productivity, job satisfaction, and overall success. Therefore, Pride Awards are a valuable tool for organizations looking to enhance their employee engagement strategies and create a thriving workplace culture.

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Water Resource Management

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Abstract

Water resource management is a critical component of addressing global environmental and socioeconomic challenges. The growing demand for freshwater, coupled with the impacts of climate change, and has made the sustainable management of water resources an urgent priority. This abstract provides a literature review of the key issues and strategies in water resource management. The article delves into issues like water resource management, integrated water resource management, water footprint, environmental flows and importance of water for the economic growth of the country. It gives an overview of the conceptual aspects of the above mentioned elements of water resource management.

Key Words: Water Resource Management, Environmental Flows, Integrated Water Resource Management.

Introduction:

Water resource management has been defined by a variety of researchers, agricultural organisations and Governmental agencies. Water resource management is the activity of planning, developing and distribution system for managing the optimum use of water resources. Basically it comprises of water cycle management. Ideally, water resource management planning has to do with the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands. Water has always been an important commodity for the human civilisation. We know that all civilisations were initiated, grew and developed in the vicinity of water and hence most of the ancient civilisations are also known as river valley civilisations for e.g. the Nile Valley civilisation, The Indus Civilisation, etc. As man expanded his knowledge of science civilisations moved away from water bodies and then were established across the length and breadth of the available land. Increasing population and growth of modern day industries than began competing for available water and management of available resources of water became extremely important.

Objective

The following article attempts to answer the questions

What is Water Resource Management?

What is Integrated Water Resource Management?

What is water footprint and its relation to water management?

What are environmental flows?

Research Methodology

The paper is based on reviews of various articles published in research journals as well on various websites, blogs, etc.

An attempt has been made to understand the literature available on various aspects of water resource management, integrated water resource management, its linkages with water footprints and environmental flows.

Water Resource Management and Integrated Water Resource Management

World Bank (WB) has defined water resources management. According to WB water resource management includes the development of surface and groundwater resources for urban, rural, agriculture, energy, mining, and industrial uses, as well as the protection of surface and groundwater sources, pollution control, watershed management, control of water weeds, and restoration of degraded ecosystems such as lakes and wetlands—is an important element of our lending, supporting one of the essential building blocks for sustaining livelihoods and for social and economic development in general, (**World Bank, Technical Note, 2003**). Another **WB** document says that Integrated Water Resource Management as **Integrated River Basin Management (IRBM) aims to establish a framework for coordination whereby all administrations and stakeholders involved in river basin planning and management can come together to develop an agreed set of policies and strategies such that a balanced and acceptable approach to land, water, and natural resource management can be achieved (World Bank, 2006).**

According to the Policy document (2012) on water of Government of India -Water resources development and management will have to be planned for a hydrological unit such as drainage basin as a whole or for a sub-basin, multi-sectoral, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations. All individual developmental projects and proposals should be formulated and considered within the framework of such an overall plan keeping in view the existing agreements / awards for a basin or a sub-basin so that the best possible combination of options can be selected and sustained (**National Water Policy, 2002**).

Integrated Water Resource Management is another important issue which has to be addressed while considering water management. It is a concept where all aspects and all stakeholders, their needs, environmental concerns are to be addressed. Water especially in form of rivers is an extremely complex commodity to be managed. Purely technical solutions as were initially designed and implemented by technocrats can't alone address all the concerns raised their in. One has to factor in various competing stakeholders and activities each of which is equally important for the country. Environmental and ecological concerns are equally important and have to be addressed while managing water resources.

Egemen and Aras (2009) have stated in their paper that as the demand of the society with respect to both ecological and chemical quality of specific River reaches, its use and protection increases, it leads to new views and strategies towards policy for river basin management. **Akpabio** (2007) has reported that integrated water resources management involves the co-coordinated development, allocations, use and management of water, and related natural resources in order to meet present and future human needs whilst maintaining the functioning of vital ecological systems. Integrated Water Resources Management (IWRM) has been defined by the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" Over the last decade's river basin management has become increasingly complex.

Gupta (2001) states in his article on Integrated Water Management that till very recently the Planning Process was dominated more by considerations of economic development. There was very little attention paid to the effect on social and cultural systems and the natural environment which today is not the case. Even today economic considerations are at the forefront while planning for water management. However, one can find alternatives to the problems being faced due to the current system of water management.

The Sydney Catchment Authority - Catchment Management Report 2007-2008 basically talks about practices for catchment management. Information about following aspects is collected: extent of gully and soil erosion, extent, type and condition of land cover and use, condition of native vegetation, condition of riparian vegetation, extent and severity of wildfires and hazard reduction burns, biomass of potential fire fuel loads, extent of priority weed species. In the past no such system or procedure is found in India to manage either water or land resources. Thus it becomes very difficult to scientifically evaluate the efficiency of water management in India.

Environmental Flows

Environmental flows are the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems. They are also known as instream flows or instream flow needs. Environmental flows are managed changes in a river's flow pattern that aim to mimic the natural flow pattern. They are intended to maintain or improve river health.

Environmental flows are important because:

1. They sustain freshwater, estuarine, and near shore ecosystems.
2. They sustain the human livelihoods and wellbeing that depend on these ecosystems.
3. They provide locations for religious ceremonies, recreation, and aesthetic value.
4. They generate income and food, and provide a safe place to live.

As such Environmental Flows is an aspect that requires attention while planning for integrated river basin management is the requirement of environmental flows or e flows of a river basin. In their paper on altered river flows, **Bunn & Arthington (2002),** have explained impact of altered flows on river ecology. Their paper basically discusses the impact of altered flows on aquatic life. Fish are one of the major species in any water body that are directly associated with livelihood concerns. According to a report by **Kelkar and Kelkar** carried out in **1956** there were 71 species of fish in the Panchaganga river but as of now as per the fishery department statistics only 29 species are found out of which 5 species are exotic. Decrease in number and variety of fish would have a direct impact on livelihood of the fishing community and this aspect will be brought out in the study. It is also essential to understand that livelihood of people residing in river basins is more directly dependent on the river water (both in terms of quantity and quality) as compared to residents of towns and cities. Specifically, it is essential to understand whether there exists any relationship between the socio-economic development of an area and its proximity to water.

Revisiting frameworks such as IWRM to resonate with these new complexities of water usage are important. Moreover, stronger, better and more efficient interlinked institutions will be required to handle the increased level of complexity (**UN Jobs and Water 2016).**

The United Nations Department of Economic and social Affairs came out with Status Report on 'The Application of Integrated Approaches to Water Resources Management' on the issue of water management and this is what they have to say: 54% of Very High Human Development Index (HDI) countries, 44% of medium and high HDI countries and 24% of low HDI countries reported high economic impacts from integrated approaches to water resources management **(2002).** The **'**Status Report on The Application of Integrated

Approaches to Water Resources Management' **2012** further gives findings from analysis of 180 countries on application of Integrated Approach to Water Resources Management in those countries. One of the findings specifies that legal frame work is available in 79% of countries with changes in their water policies. The change however is not translated into actual implementation at ground level. India falls into the medium HDI country as per the 2012 UN report. The progress of implementation has been slow or has even regressed in low as well as medium HDI countries. So when we look at ground level at India we still find that there is a lot that needs to be done to implement approach of Integrated Water Resource Management.

Gupta (2001) states in his article on Integrated Water Management that till very recently the Planning Process was dominated more by considerations of economic development. There was very little attention paid to the effect on social and cultural systems and the natural environment which today is not the case. Even today economic considerations are at the forefront while planning for water management. However, one can find alternatives to the problems being faced due to the current system of water management. It would be interesting to find out the impact of water availability on the economic growth and development of the country.

Thus one can see that Water Management basically talks about a holistic approach involving social, economic and environmental concerns. The concerns of all stakeholders are to be addressed so that their needs can be addressed. At the same time the needs of environment and sustainability are also to be taken into account so that a balance can be sought between the human needs and environmental needs of water. However, when we look at present systems of water distribution and management in India we find an absence of any such approach. Though the Indian Water Policy 2012 of Government of India mentions various uses of water and its allocation we don't find it being implemented at the ground level. The earlier approach to management of natural resources was more economically oriented with the assumption that all resources on the earth are meant to be exploited for human and human needs only.

The researcher has not been able to find any literature in India which shows the implementation of a holistic approach water resource management in its true sense. An attempt will be made to show relation between land management, cropping practises and rise in socio-economic indicators. In economics, the Dutch disease is the apparent relationship between the increase in exploitation of natural resources and a decline in the manufacturing sector (agriculture). The mechanism is that an increase in revenues from natural resources (inflows of foreign aid) will make a given nation's currency stronger compared to that of other nations (manifest in an exchange rate), resulting in the nation's other exports becoming more expensive for other countries to buy, making the manufacturing sector less competitive. While it most often refers to natural resource discovery, it can also refer to "any development that results in a large inflow of foreign currency, including a sharp surge in natural resource prices, foreign assistance, and foreign direct investment". Water as a natural resource does not come under this category as there is no question of exporting water like other commodities.

Environmental Sustainability

The study of water management started from early 1990's. The concept of sustainability was introduced by the Brutland report in 1987. The term was used by the Brundtland Commission which coined what has become the most often-quoted definition of sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs (**Report: Our Common Future, 1987**). Sustainable development ties together concern for the carrying capacity of natural systems with the social challenges facing humanity. As early as the 1970s "sustainability" was employed to describe an economy "in equilibrium with basic ecological support systems (**Zuo Qi Ting, et, al. 2007).** In **1996, the Working Group of the International Hydrological Program (IHP) of UNESCO** defined sustainable management of water resources as "The management and use of water that supports society and its well-being into the indefinite future without degrading the integrity of the hydrological cycle or the ecological systems that depend on it".

The perceptions of what is required for sustainable water resources management and sustainability science in general have undergone major changes over the past decade. Initially, water resources management followed an instrumental "prediction and control" approach, dominated by technical end-of-pipe solutions (**Pahl – Wosti, 2008**). The author basically explains how the learning through trials has brought about the present understanding of the concept of sustainable management. The **European Water Framework** that came into existence in **2000** also set up innovative measures in the European Society. These are:

- An integrated approach expanding the scope of water protection to all waters, surface waters, and groundwater;
- The hydrological principle where water management is based on river basins;
- The obligation to achieve a "good status" by 2015;
- A "combined approach" of emission limit values and quality standards;

- Getting the prices right by introducing the principle of cost recovery;
- Getting citizens involved more closely by prescribing public participation in the development and implementation of the WFD.

In India most of the systems of water management seem to be based on the Tennessee Valley Authority (TVA) approach of United States where the focus was more on compounding and distribution of water rather than sustainable water management **(Tortajada, 2001).**

Water Footprint

Traditionally the terms ground water and surface water have been used to denote water present in aquifers and rivers (also rivulets, streams, ponds) respectively. Of late two new concepts the green water and blue water have come into existence. Both surface water and ground water are denoted as blue water while water present in evapotranspiration cycle (water present in trees, crops and other vegetation) has been termed as green water (Taiekan Oki, et al, 2006). The water foot print of various nations has been calculated using data from 1997 – 2001 for all nations. The global average water footprint is 1240 m^3 / cap / yr. the water footprint of India is 987 m^3 / cap / yr ie. 14 % of the world water usage. In fact India forms a group of select eight countries (China, USA, the Russian Federation, Indonesia, Nigeria, Brazil and Pakistan) that consume 50 % of the world's water supplies. A break up of the water footprint in terms of consumption of water shows that highly developed countries use more water for production of industrial goods while in a country like India 92 % of water is used for consumption of agricultural goods (Hoekstra, Chapagain, 2007). One of the objectives is to study water consumption of the people for irrigation in the study area. Hence an understanding the concept of water footprint is essential to understand and analyse water consumption patterns of irrigation. Another fact is that increased water usage leads to increased economic growth (Hoekstra, 2004) and impacts the water footprint of a nation. Calculation of water footprint at a district level would be difficult but the researcher intends to try to understand the water consumption in terms of the water footprint concept.

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Water and Economic Growth

A document prepared for the HSBC by Frontier Economics explores the relationship between water and economic growth. It says that that an investment of 3.06 million US dollars in access to water and sanitation would give an annual potential economic gain of 5.2 % in terms of percentage of GDP. The cost benefit ratio is 3.2 and the payback period would be 7.0 yrs. It further states that while calculating the World GDP of top ten most populated river basins two: The Ganga and Krishna are from India. The Krishna Basin (of which Panchaganga is a major tributary) has 1.3 % of the world population and the GDP from this basin is 0.2 % of the World GDP at 2010 figures. The blue water footprint as a percentage of natural runoff in the Krishna Basin is 17, 59,152 cubic meters per month. Agriculture is responsible for 92 % of the total water footprint in the world while drinking water and industrial usage accounts for the remaining 8 % (Hoekstra et el, 2012). It is quite obvious that productivity of agriculture is dependent on water resources and an attempt has been made to find the relationship if any between the availability of water and the increase in economic indicators.

A **UN report titled 'Water and Jobs'** states that water is an enabler of economic activity. As such effective management of water supply is a key element that should be incorporated into national employment Policy.

Scarcity of water could negatively affect growth (Barbier, 2004). This is of paramount importance in agro-based economies like India. Proper utilisation of water can take place only through proper, holistic and sustainable management of water resources. The quantity of land available for agriculture is limited. It can be reduces if agricultural land is used for other purposes or it can increase if forest land or other barren land is brought under cultivation. One way of increasing agricultural with the same amount of land is to go for multiple crops on the same land. Obviously this would require stored water in rain fed areas for irrigation. **Brown 2006** says that

countries with a higher Seasonal Storage index (SSI) have higher GDP. India has a SSI of 356.6 and GDP of 555 US dollars (Year 2003)

In all industrial countries, the flows of almost all major rivers are regulated and managed, storing water for multiple uses, reducing peak flows, increasing low flows and protecting water quality, thus reducing the risk of water-related shocks and damage, increasing the reliability of water services for production, and reducing other negative impacts, such as disease (**Gray 2006**).

Water and economic growth are linked to each other and as such scarcity of water would lead to lack of growth and development. It obviously would then lead to lowering of the values of social indices of socio – economic development. The relation between water scarcity and has been well established (**Grey, Sadoff, 2007**). The water management and water utilisation therefore needs to be studied. Water is a finite resource and one can only improve efficiency of yield using various techniques of irrigation but one can't per say increase the quantum of water. The supremacy of drip irrigation with respect to water efficiency and productivity has been well established (**Narayanmurthy, 1997**). One of the objectives therefore relates to whether the farmers in the study area use this method and if they don't their reasons for not using drip irrigation.

Conclusion

Thus in order to understand water resource management in a holistic perspective it is essential to incorporate all aspects while designing and maintain systems and processes that manage water as resource. Need of water for human development is essential and one can't imagine life (no matter how advanced or modern) without adequate requirement of water. Trying to manage water without understanding various ecological, geographical, economic and hydrological perspectives would be disastrous to environment and the human life dependent on that very resource for its survival.

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Industry-Academia collaboration modelsfor the medical device development

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ABSTRACT - The article covers in detail the subject of collaboration - one of the most effectivestrategies for managing growth. Scopes of implementing collaborative models in the Indian scenario for medical devices product development are many and the relevance of these models to India needs immediate consideration. The medical devices industry is represented heavily by MSMEs. The industry overview section details that India still relies significantly on the importationof medical devices, and local manufacturing still addresses only lower-end products. The article explores the power of collaboration through examples of medical technology and the medical devices sector. The sector of medical devices especially demands collaborative efforts, mainlybetween industry and academia because of the involvement of a large spectrum of diverse technologies, like chemicals, electronics, biomaterials, metallurgy, optics, mechanics, fluidics, andcomputer programming, to name a few. Some successful case studies are described in the article involving industry-academia collaborations in developed and developing countries, and learnings from these cases are summarised. Collaboration models resulting in successful medical device development are also covered. Collaborations between countries and recommendations by bodies like WHO on collaborative models are also discussed. These collaborations are not always smooth,and the article lists the barriers encountered in such collaborations. Legal and procedural aspects to support such collaborations are also stated.

Keywords: Industry – academia collaboration, medical devices, models, barriers

Introduction - Industry Overview

During the pandemic, the market for medical devices declined by 3.7% though the pharmamarket had grown during the same period. With this decline, the size of the global medical devices industry was around USD 432.23 billion in 2020, with a decline on a year-on-year basis. However, in the next eight years, the value projection is USD 657.98 billion, and its growth rate would be 5.4% pa. Increase in patients, diagnostic procedures, and surgeries are projected to increase during the coming years which will support upping in demand for medical devices. Both capital equipment and consumables will be in more demand in both developed and developing countries (Fortune Business Insights, 2023). However, this demand has seen large differences between the developed and the developing countries. A good example is cardiac procedures – about 1000 per million population in the US versus only 18 in the Africansubcontinent (Bergsland, Elle & Fosse, 2014).

India now produces many disposable medical devices, like catheters, perfusion sets,extension lines, cannulas, feeding tubes, needles, and syringes, and even implants, like cardiacstents, drug-eluting stents, intraocular lenses, and orthopaedic implants. The Medical Devicesindustry in India has shown significant growth during the past decade (India Brand Equity Foundation, 2020). The sector is represented by large multinationals, medium-sized companies, and smaller companies. Market size estimation for Indian medical devices is aboutUS$ 12 billion in 2020 and is growing at an expected rate of 15%, which is significantly higherthan the global growth rate for the industry. India is the 4th largest medical devices market in Asia. It should also be noted that India has an overall 70-80% dependence on imports for medical devices and there is a large gap between the country's demand and its internal production of medical devices (Informa Markets, April 2020).

The medical devices industry has been given the status of a focus sector by the governmentof India at the time of the "Make in India" campaign. Many initiatives have been suggested and implemented by the Ministry of Health and Family Welfare (MOHFW) as well as the Central Drugs Standard Control Organisation (CDSCO) to increase the export of medical devices from India (India Brand Equity Foundation, 2020). The industry is highly fragmentedwith about 1000 domestic operators in the device manufacturing sector with the production ofgenerally lower end of technology products. However, a paradigm shift has been seen in recentyears and the initiatives have started to produce cost-effective, medium-end medical devices (EEPC India, December 2013).

Literature Review – The complexity of medical devices and the need forcollaborations

The development of most medical devices needs an understanding of a large array of technologies. Some of the technologies commonly encountered for medical devicedevelopment are chemicals, electronics, biomaterials, metallurgy, optics, mechanics, fluidics, and computer programming. If we compare medical devices with their pharma peers, for the development of a new drug, knowledge of very few sciences may be adequate. Though pharmaresearch is also complex, the spectrum of areas involved in medical device development is certainly much larger, comparatively. Even from a regulatory perspective, it is not always practical for the regulatory teams to develop special expertise in all the fields involving a medical device. Kahn, in 1991, mentioned this point besides other complexities of medical devices in a comparison of devices with medicines. Medical device development also involvesthe consideration of ergonomics. Convenience, suitability, and safety of the final user are important parts for a device. A well-designed device with convenience for the user during thecare of a patient is important. Sufficient guidelines and studies are not available in this area ofergonomics (Martin, Norris, Murphy & Crowe, 2008). Medical device designing considering the practical situations of developing lower-income nations is also part of the problem and theauthors recommend collaboration between developing countries and advanced countries so thatsuch situations can be adapted (Saidi, & Douglas, 2022).

The key to success in such situations is Collaboration (or Partnerships or Teamwork). Thedictionary defines collaboration as the state of having shared interests or efforts (Merriam- Webster.com, 2023). Dosanjh (2022) has rightly mentioned the title of his research article as "Collaboration: The Force That Makes the Impossible Possible."

Research Objectives

The objective of the article is to do a critical review of the processes of collaboration, mainly industry-academia collaboration, and the models being practised for the collaboration process in outside countries as well as in India, and then derive learnings from this analysis, with the focus on medical technologies and medical devices. One more objective is tounderstand success factors as well as barriers to industry-academia collaborations. Thus, the article aims to cover-
Case studies of successful industry-academia collaborations abroad pertaining to medical technology
Learning points from these case studies
Barriers in these collaborations and care to be taken for successful outcomes.

Research Methodology

Some of the advanced countries that spend more amount on research and development have usedcollaboration models effectively for research. The critical analysis of the literature review describing these models and processes is the methodology adopted here.
Industry-Academia Collaboration

Cases, models and methods

Academic institutions are an important resource for research. Collaboration of the industry with academic universities can therefore be a good model for success (Chung, Ko & Yoon, 2021). Academic institutes thrive on innovations and discoveries while companies being process-driven, often struggle with their ability to innovate. (Chen, Pickett, Langell, Trane, Charlesworth, Loken, Lombardo & Langell, 2016). The partnership between academics and the industry – an alliance that is important for both sides, helps in technology transfer and completion of the innovation cycle. Both academia and the industry have different missions, and different skill sets, and their cultures also differ, however (Pantanowitz, Bui, Chauhan, ElGabry, Hassell, Li, Parwani, Salama, Sebastian, Tulman, Vepa & Becich, 2022). WHO, in their document, requests members to formulate the right national strategies for the assessment,planning, procurement, and management of health technologies and also recommends that thisshould be done by collaborating with people involved in technology assessment. Though the document highlights the role of biomedical engineers, it also recommends "interdisciplinary collaboration" as per the regulations of each country involved. The document further recommends that Governments, professional councils, and associations need to develop the right models and inter-professional collaborations. Documentation of associations (national aswell as international) involved in promoting collaboration between individuals,

governing bodies, and academic institutions is also recommended. Further data is also given on the WHOwebsite including international collaborative work (World Health Organization, 2017).

Lester & Sotarauta (2007), in their book titled "Innovation, Universities, and the Competitiveness of Regions" (the title is self-explanatory) has detailed a case study, now known as "The Oulu Phenomenon". Oulu City in Finland, an industrial city located in the center-west of Finland, has a population of above 130,000 people. This city was struggling dueto economic slowdown and this struggle created, or forced, trust and solidarity among the population. This was the main force behind their collaborations, both formal and informal. Thiscollaboration story is described as the Oulu Phenomenon, triggering a series of positive situations. The Government of Finland, the city itself, and the local companies made supportivestrategic investments, and a science park was created there in the city with further support fromthe University of Oulu and a European foundation. The relevant chapter in the book stated above covers cases for medical device technology including hospital technology, telemedicine, healthcare technology, and wellness devices. The medical devices industry is represented by smaller companies. In this city, the science park, the University Hospital, the Oulu Polytechnic,the medical department of the University of Oulu, and companies are situated in close vicinityto each other since the size of the town is relatively small. This closeness prompted and easedface-to-face meetings – both formal and informal. These networks were found to be importantfor technology transfer. Organizations related to each other through formal ties in organized networks, while individuals were connected through informal networks. Seventy-five percent of medical devices were developed in the networks of manufacturers and potential users like hospitals and also involved network members like universities and research institutes, scientificfoundations, government agencies, consultants, and distributors. The authors note that trust between the parties involved makes them willing to share knowledge related to their core competence without apprehensions. The authors conducted a study with the objective of exploring the role of university-industry collaboration in medical device development and howthe perception of collaborations in the Oulu region, with a snowball sampling method. The snowball sampling method was used because it would easily locate people connected informally in these networks ("n" was 40). Most of the managers stated that the University of Oulu was the most important academic partner. Few also collaborated with universities other than the University of Oulu. The timeline for new product development was shortened becauseof such collaboration with the university, and competitiveness was increased. It may be worthnoting that the research found that despite this positive effect on the universities, the managersfelt that the University could do more to collaborate.

One more case of Japan can also be quoted here. A unique collaboration model called Hamamatsu Method for medical devices has been presented by Yuko (2020). Japanese medicaldevices market has a situation of export dependence like that in India but to a lesser degree. The author states that the local requirements for medical devices are growing year after year and importations are increasing, while exports have not increased proportionately, and this creates an imbalance between import and export. A network was created between AMED, an agency for medical research and development, and Mitsubishi Research Institute, Inc. with theobjective of promoting collaborations and support. Hamamatsu, a local city in south-central Japan, was used as the platform for hypothesis testing of a new model where Commercial Coordinators (CDs) were involved in the successful implementation of collaborations. The roleof Commercial Coordinators was multifaceted – education through methods like seminars, matching requirements through hospital visits and consultations, funding through R&D budgets, support on the R&D front like space and equipment arrangement, and then technologytransfer support. The article, in the form of small summary cases, discusses success stories withexamples as well as complications encountered in some cases. The role of Commercial Coordinators here appears to be critical and the same model, with local adaptations, can be used in more places, as the author concludes.

Tsuruya, Kawashima, Shiozuka & Nakanishi (2018) have also given a fairly detailed outline of the progress of academia-industry collaborations in Japan in the medical field including medical devices. This article mentions a historical perspective of how a humble beginning of collaboration started as early as the 12th century, and how it has progressed so far.This historical outline also describes how the universities started in Japan (in the 12th century), the influence of the Western styles and culture, parallels between industry-academia models inthe US and Japan, how some Japanese professors started their companies, and then the currentscenario. It also gives a vivid description of collaboration platforms like DSANJ, and AMED,a national agency stated above, and also a case study of the Kyushu University hospital centre.It will clearly appear to the readers that collaborative culture is a process and not an endpoint. A simple method for initiating collaboration among industry, academia, and government is to organize a workshop involving these parties as per Linehan & Chaney (2010).

CAREFOR (Clinical Academic Cancer Research Forum) is one more platform created forimproving the industry-academia collaborative interface. Barriers hindering broader collaboration in Europe in the field of academia-industry cancer research were seen, promptingto form CAREFOR platform. Industry representatives were joined by academic professionals who had good experience. These team members had joint discussions about various aspects (related to clinical trials) and put forth collaborative success stories. Legal points and contractspertaining to the subject were also discussed, and broad principles of interaction and access todata were also addressed by Stahel, Lacombe, Cardoso, Casali, Negrouk, Marais, Hiltbrunner,Vyas & Clinical Academic Cancer Research Forum (CAREFOR) (2020). (on behalf of the Clinical Academic Cancer Research Forum (CAREFOR)). Though dealing with the subject of cancer research, this model appears to be relevant for the industry-academia collaboration for medical devices, deserving its mention here.

The case of the University of Utah's annual Bench-to-Bedside competition will also be relevant here. This was a simple way of accelerating the innovation process through industry- academic partnerships, mainly because The Centre for Medical Innovation gathered a team ofstudents, surgical residents, and clinical faculty at the University of Utah's annual Bench-to- Bedside competition. All participants gathered on a voluntary basis. This university program, the Bench-to-Bedside medical program, had an objective of medical innovation. In thisprogram, the industry partner acted in the role of a business mentor. This group of volunteers studied the therapeutic landscape as well as environmental constraints. Later, to facilitate the usage of a device, the group took the help of a simulation to understand human factors like usage requirements and design. First, a digital image was created, and later, the image was converted into a physical object using a 3D printer. In the final stage, clinicians (here, obstetricians and gynaecologists) were informed about how to use a device and were asked touse the device (Chen, et al., 2016). A successful model of industry-academic partnership!!

Selection of the right partners in such projects is important, and Chung, et al., (2021) havedescribed this step of the process in detail. Their study presents a partner identification approach that is based on innovations selecting the right university inventor groups for academic-industry collaborations. Their approach suggests four steps in the process – 1. Patentdata collection and institution identification, 2. Grouping the inventors of the universities, 3. Screening these groups against the needs of the industrial firms, and, 4. Partner groupidentification based on competence, concentration, and size of the inventor group.

An interesting study on collaborations in South Africa for medical device development among four sectors namely academia, healthcare sector, Industry, and science & support drewcollaboration networks, and after that, the links between institutions were studied. The resultsof the study may be useful to recommend strategies and policies for medical device development. (Jager, Chimhundu, Saidi, & Douglas, 2017).

And here is an Indian story. Siemens Healtineers, India, is working on these lines recently.With an eye on the fast-growing Indian medical devices market, Siemens Healthineers has scaled up R&D and has emphasized tie-ups with academic institutes along with hospitals and local firms (Press release by MeitY, 2023).

Clinicians - Engineering Collaboration models

Engineering is of prime importance in device development, mainly because of the familiarity of this faculty with precision medicine and artificial intelligence which applies to many devices. Nursing faculty becomes equally important in the field, and this demands collaboration between these two disciplines. Zhou, Li & Li (2021) have explained a case studyof collaboration between these teams. The authors also note that such collaborations have not been explained well, which was the reason why they have studied this collaboration between engineering and nursing in healthcare. Their study uses a scoping review using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension. An interdisciplinary collaboration model was used to visualize the results in 60 studies which were found to be suitable as per the inclusion criteria selected after extensive literature study. An interdisciplinary collaboration model was constructed for the results. The findings of the studywere, i) These collaborations are in their early stages and have not emerged fully; ii) Involvement of nurses should be more and should be at an early stage in the future. iii) The design phase and requirement analysis stage involvement for nurses is important.

For complex devices, involvement by clinicians is important for research sustainability. A research model addressing this issue was proposed by The University of Rochester Cardiovascular Device Design Program through a multidisciplinary solution. This program works through a collaboration between the Schools of

Medicine and Engineering (Chandra, 2012). The author notes a gap between the users, that is clinicians, and the engineers who design these devices, and recommends collaboration among the medical device industry, engineering department, and clinical faculty. This university has started a one-year master's program (The University of Rochester Cardiovascular Device Design Program) with the aim of a new paradigm in the device designing area.

A novel collaborative process for design optimization and production for face-visors usedregularly during the Covid pandemic is described by Din, Althoefer, Farkhatdinov, Brown, Morgan & Shahdad (2021). This is a classical case of collaboration journey between an academic group and medical clinicians. The article elaborates on how unmet needs for this product led to the process of innovation and also details timelines and steps followed in the process. The face-visor thus developed by the collaborative team satisfied many important criteria like reusability, convenience in the form of adjustability, local production feasibility, and high utility with a controlled price and a possible scale-up for the production. This single team delivered more than 15,000 face visors through this collaborative journey. The authors also note that CAD-trained engineers were involved in the collaborative process and that facilitated the process of product development by decreasing the innovation time. This Barts and Queen Marry University of London collaborative project for Visors (The Barts and QMULVisor™) is a typical success story of collaboration.

Intercountry collaboration models

Uchida, Ikeno, Ikeda, Suzuki, Todaka, Yokoi, Thompson, Krucoff, Saito & Harmonizationby Doing Program Working Group (2013) mention a successful collaboration between Japan and the USA for developing new medical devices. Harmonization by Doing program (HBD),was started with the background that financial budget limitations affect efficient devicedevelopment, and repetitive spending in different geographies for device development is not practical. Global networking is needed in such a situation. The HBD program has four workinggroups each addressing different requirements like global trials, post-market registration, infrastructure, methodology, and clinical trials. Such programs are important for efficiently delivering newer medical device ideas with better financial efficiency.

To facilitate collaborative efforts of multilingual groups, the European Federation for Medical Informatics (EFMI) Association has created a collaboration tool called MIMO (Medical Informatics and Digital Health Multilingual Ontology). EFMI is the Working Group on Health Informatics for Inter-regional Cooperation. MIMO has uploaded about 1,000concepts and above 300 newly created concepts and this platform is regularly updated. This tool provides a medical informatics multilingual thesaurus where the medical terms can be translated into more than 30 languages to facilitate better understanding and collaboration among multilingual groups or countries (Benis, Grosjean, Billey, Montanha Dornauer, Crișan-Vida, Werner O Hackl, Stoicu-Tivadar & Darmoni, 2022).

Barriers Affecting industry-academia Collaborations

These collaborative relationships are not as rosy as they sound, and some authors have explored complications, dispassionately studying difficulties, hurdles, issues, and suggestionsto resolve them. This section will describe success stories and some models with suggestions and the next section of the article will describe difficulties noted by some authors in such relationships. We will now see some studies describing barriers encountered and care to be taken for successful outcomes from collaborations.

A small but data-based study provides good insight into the extent of industry and academic participants' collaborations. Publications with industry affiliations and participants at an international conference were coded and analysed for industry collaborations. The data indicated that in 2018, such collaborations were to the extent of less than 5%. Though a roughestimate, this is a good way of having a quick analysis of the situation. The authors also studiedthe barriers in collaboration and listed these as motivational differences (actual or perceived), challenges in publications, and outcomes (Blanch-Hartigan, Yule, Cummings, Smith & SchmidMast, 2019). The rules of these partnerships need to be clear from the beginning and Pantanowitz, et al.,(2022) not only highlight these divergences but give a detailed outline of these rules, including legalities. Their article discusses the advantages as well as disadvantages of such partnerships,details areas of conflict of interest, and describes recommendations for success. They note thatfor an academic institution, a high priority area is education while for an industry, their high priority area is innovation which, for an academic institution, is the least priority area. Sponsored Research Agreement (SRA), Technology Transfer Agreement (TTA), and Consulting Agreement are discussed in the article. Overview of some other relevant agreementslike Confidential Disclosure Agreement or

Non-Disclosure Agreement (CDA or NDA), Material Transfer Agreement (MTA), Data Use/Transfer Agreement (DUA), and Clinical TrialAgreement (CTA) are also outlined. Some important recommendations for a successful collaboration, according to them are - building trust, compatibility of values, creating boundaries, financial reviews, governance review, transparency, full disclosures, geographical considerations (for international partnerships), and engagement of academicians.

One more study by Mirza, Al Sinawi, Al-Balushi, Al-Alawi & Panchatcharam (2020) touches on this subject of academic-industry collaboration and discusses the difficulties and barriers in such a collaboration. The authors have studied collaboration in some major academicinstitutes in London, UK. The study explores attitudes, beliefs, perceptions, and opinions of clinicians and academicians towards collaboration with the industry through an online questionnaire involving a four-point Likert scale and responses from researchers followed by interviews with some of them (a mini-focus group). The reputation of the industry was comingout as the major barrier perceived by the academicians. Academic people involved believed that bias for the products rather than caring for the patients, primary concerns not being patients, publication bias, and major interest being financial gains are important issues againstthe industry. though this study is not related to the field of medical devices, the premises beingindustry-academia collaboration, these issues mentioned in their work may be highly relevant. One more study on critical issues for effective academia-industry collaboration conductedin Japan by Tsubouchi, Morishita, Tabata, Matsui & Kawakami (2008) in the field of medicinecovered nine representatives of Japanese companies. The study noted that the industry representatives encountered inappropriate systems in academic institutes, a deficit of understanding of industry issues by academic institutes, insufficient support system by the government, and a critical view of such alliances in the public eye as the major barriers. The institutes always have scholars, researchers, and specialists of knowledge, and one suggestionby the authors was to create academic seats in the industry or systems whereby people can move easily between industry and academics.

Austin, May, Andrade & Jones (2020) have described five case studies and discussed issueshindering university-industry collaborations and facilitators for such collaborations. They notethat successful networking, higher expectations, idea evaluations, and technical support from universities were the most desired contributors to a successful relationship. Unrealistic expectations on time and fund involvement were the hurdles. One point worth noting here is that most of the participants in the study expected exchange of knowledge, and not cooperative research or technology transfer. Networking with others was one of the major advantages notedhere.

Discussions

Industry overview for the medical devices sector gives clear indications that the situation of over-dependence on imports by India needs deeper answers and the answer may be in new product development. The complexity of medical technology asks for multifaceted expertise and therefore, collaboration, for new product development. The success stories of Japan and Finland indicate the importance of cultural factors in successful collaborations, as well as initialinvolvement by the academic side. Facilitators connecting various agencies, as in the case of Japan, may suggest a simple and effective way of handling sensitivities. Models like CAREFOR and bench-to-bedside are quite creative and seem fairly simple to implement. In allthe situations discussed, initiation or take-off appears to be the most critical stage. This has parallels in forming teams for tasks, and experienced readers will appreciate that the most difficult stage in team formation is the first stage. This stage will be achieved after the stakeholders have developed a common understanding, and after this stage, the journey seemsless troublesome, though not smooth. Definitely, the scopes for implementing models which are described in this article are many, inthe Indian context.

Limitations and further scopes of the study

One limitation of this study is that almost all the cases and situations are from different parts of the world. The readers would appreciate that there are many differences across borders, like culture, regulatory framework, economic background, and also, languages. These differences do affect the processes when planned for implementation, and some of the learningsmay not be reproducible without the required adaptations. Analysing the possible influence ofsuch factors on selected models may be an interesting area to study further in this regard whichwill help better implementations.

Conclusions

Parking barriers aside, many learnings appear to be practical and possible to implement. The success stories of these collaborations clearly indicate that in today's turbulent scenario, collaborations can be a strong possibility to lead the research and development of newer products more efficiently. To conclude, with some modifications, balancing, and adjustments,these models can very well be used in the Indian scenario.

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