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Topic: Decision Making Tool for Water Efficiency in Built Environment

Ar. Anjali Pal
Deenbandhu chhotu ram university of science & technology
Murthal (Sonepat)
Department of Architecture

Abstract:- **Life and civilization cannot exist without water. The earth is surrounded by water, but only a small part (around 0.3 percent), is used by human beings. The rest of it which is around 99.7 percent is in the oceans, soils, and floating in the atmosphere. (CSO, 2018). Due to rapid growth of urbanization there is more pressure on the fresh water. "India is the second populated country in the world with 1.2 billion people (according to Census of India, 2011)" (UNICEF, 2013). India is now facing water stressed situation and heading towards water scarcity situation by 2051.**

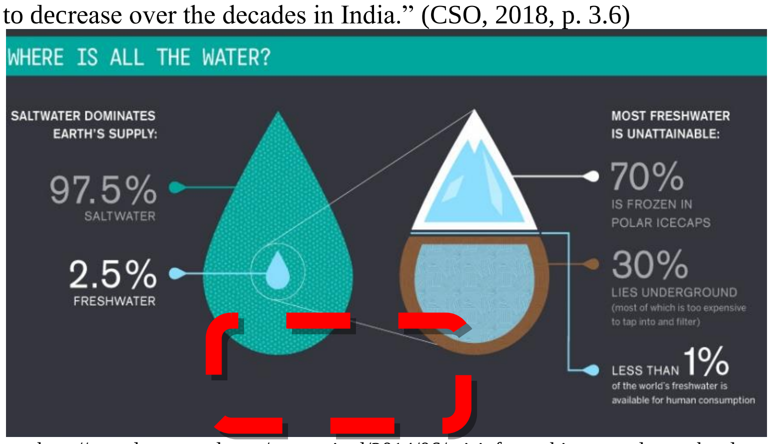
In this regards, this research has been carried out with an attempt made to study the processes of realization of retrofitting potential and incorporating it in the real world scenario. The research includes a study and comparison of various water norms and codes to establish a minimum performance benchmarking criteria for the equipment's constituting building services such as, Plumbing system.

It also includes an in-depth study of understanding of services and the various water technique associated with them.

Keywords: Water efficiency, Water stressed, MPC (Matrix paired comparison), MADA (Multi Attribute Decision Analysis)

INTRODUCTION:

India is the second populated country in the world with over 1.2 billion people (Census of India, 2011). (UNICEF, 2013, p. 1). "In India, industrialization and urbanization have not yet reached the peak levels considering ever increasing demands of the growing population. This translates to a mounting pressure on the freshwater in the country. The water resources are being increasingly stressed not only by over-abstraction, but also by pollution and climate change. However, the per capita availability of water has been estimated to decrease over the decades in India." (CSO, 2018, p. 3.6)



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International Journal of Engineering Research & Technology (IJERT)
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Per Capita Water Availability in India

Year	Population (Million)	Per capita water availability ($m^3$1Year)	Remarks
1951	361	5178	
1955	395	4732	
1991	846	2210	
2001	1027	1820	
2011	1211	1544	water stressed
2015	1326*	1441$	water stressed
2021	1345a	1421$	water stressed
2031	1463a	1306$	water stressed
2041	1560 a	1225$	water stressed
2051	1628 a	1174$	water stressed

*projected 2011census
Note: a: Population figures for 2021 to 2051 are taken from projected population by Planning Commission
$: The per capita availability from 2015 onwards has been calculated from 2017 WRA estimate
Source: CSO (2018), EnviStats-India 2018
As per Falkenmark Water Stress Indicator, a per capita availability of less than 1700 cubic meters is water-stressed condition, while if per capita availability falls below 1000 m3, it is water scarcity condition.

3.AIM AND OBJECTIVES

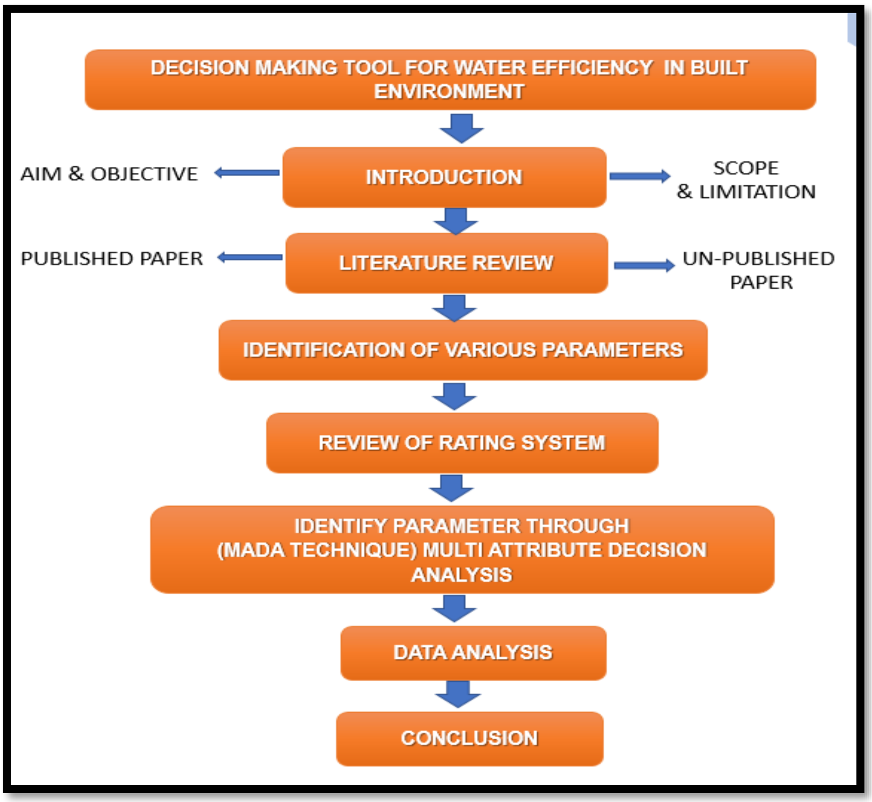
The aim of research:

- To explore the best strategies of water Conservation.
- To explore the tool for water efficiency.

The research -based objectives as follow:

1. To study different water conservation technique through literature reviews.
2. To study the water criteria in Rating/Review (such as LEED, GRIHA, IGBC)
3. To analyse parameters collected from literature review.
4. The important parameters will be analysed through survey

METHODOLOGY



SCOPE AND LIMITATION

The scope of project deals with application of various water conservation techniques on a building at design stage to achieve NBC (National Building Code) Standards. It does not include any major alteration to the design aspects of the building.

LITERATURE REVIEW CONCLUSION

Based on literature review, studies and survey, the study of water efficiency tools such as water supply, fixtures, pumps, rainwater recharge structure, types of filters used, landscape technique, Irrigation practices and waste water treatment has been analyzed above in building context is found to be a research gap which is very important so that it can be used as a tool for decision-making in-built environment.

The List of parameter affecting is Ease of Installation, Rate of Flow, Facility Management, Cost.

PARAMETERS

S.NO.	DESCRIPTION	SYSTEM	PARAMETERS
1	**PLUMBING**		
i	Type of water supply system for high rise building	• Direct supply system from mains public or private. • Gravity distribution system. • Pressurized distribution system (Hydro pneumatic pumping system). • Combined distribution system	• Energy consumption • Proper residual pressure • Ease of installation • Facility Management • Reliability
ii	Type of piping systems,	• Single stack system • One pipe Partially ventilated system • One pipe Fully ventilated system • Two pipe system with common vent pipe • Two pipe system with independent vent pipes	• Ease of installation • Facility Management • Performance • Ease of integration • Cost
ii	Efficiency improvement of motors and pumps.	• Centrifugal pump • Rotary pump • Reciprocating pump	• Cost • Energy efficiency • Performance • Ease of integration • Ease of installation
iii	Fixtures	• Sensor • Water efficient fixture • Auto control valve • Pressure reducing valves	• Rate of flow • Ease of installation • Maintenance • Cost • Proper residual pressure

S.NO.	DESCRIPTION	SYSTEM	PARAMETERS
2	**LANDSCAPING**		
		• Minimising Lawn area • Maximise native and adapted species • Maximise tree/shrub plantation • Use of efficient technologies • Grouping of similar plant species as per the water requirement • Xeriscaping • Install soil moisture or rain sensor	• Water efficiency • Ease of design • Life span • Maintenance

S.NO.	DESCRIPTION	SYSTEM	PARAMETERS
3	**IRRIGATION PRACTICES**		
		• Micro-drip • Micro-spray • Multiple-sprinkler • Sprinkler, large gun • Smart irrigation system • Sub irrigation system	• Water efficiency • Rate of flow • Cost • Facility Management • Payback period

S.NO.	DESCRIPTION	SYSTEM	PARAMETERS
4	**RAINWATER RECHARGE**		
i	Recharge structure	• Recharge pit	• Improves quality of ground

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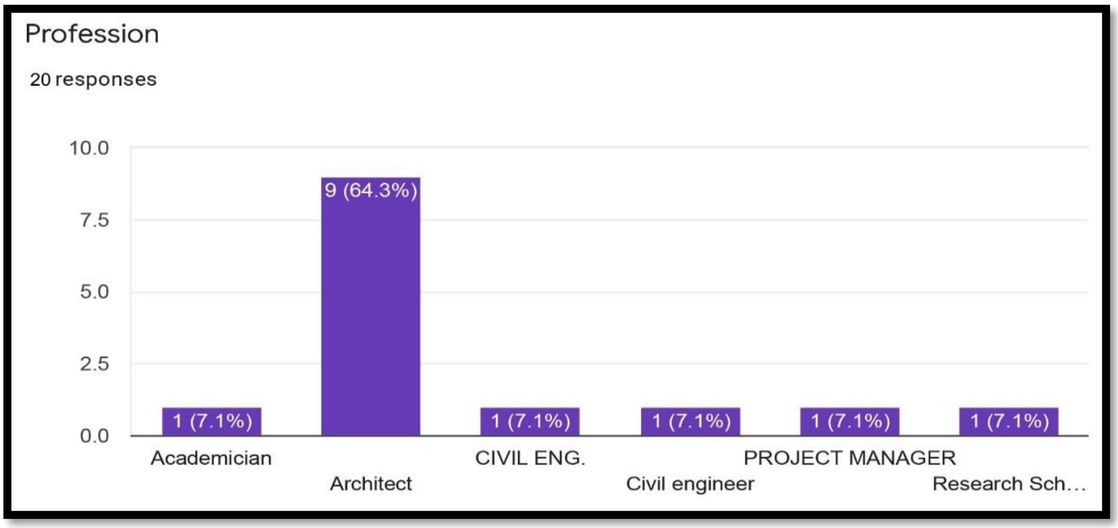
		• Recharge trenches • Reuse of abandoned dug wells • Recharge shafts • Lateral shafts with bore wells • Deep injection well	water • Reduces run-off • Ease of construction • Costing • Maintenance
ii	Filters in RWH	• Cloth filter • Sand filter • Reverse sand filter • Dewas filter • Varun filter • Desilting chambers	• Amount of silt load • Quality of Run-off • Catchment Area • Costing • Type of recharge structure

REVIEW/RATING SYSTEM

This section presents a review on the strategies of water conservation. The section deals with different parameters of Rating system in Indian context (such as GRIHA, LEED (IGBC) and IGBC. All the parameters have been analysed in each criterion. The points observed are Water quality. GRIHA EXPLAINS about water quality while others criteria do not deal with. In some criterion such as irrigation system, (in case of IGBC single parameter have been considered and in others rating system this criterion has been merged with Landscape

Data Collection

This chapter deals on the subject of Data collection. The tool used is MADA (Multi Attribute Decision Analysis). The parameters were analysed on the basis of data collection. The data was collected from Architect, Civil Engineer, Research scholar.



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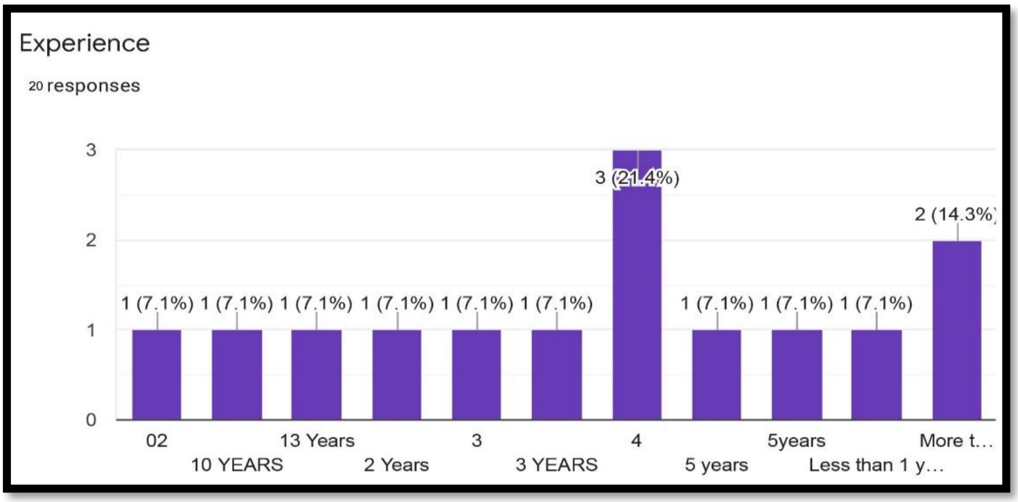

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1.Plumbing

(i)Type of water supply system for high rise building

MPC for Energy Consumption	Direct supply system from mains public or private.	Gravity distribution system	Pressurized distribution system (Hydro pneumatic pumping system).	Combined distribution system	EIGEN VALUE	NORMALISED EIGEN
Direct supply system from mains public or private.		0.143	7	0.143	0.506097	0.12652425
Gravity distribution system	7	1	7	3	2.099697	0.52492425
Pressurized distribution system (Hydro pneumatic pumping system).	0.143	0.143	1	0.14	0.176075	0.04401875
Combined distribution system	7	0.33	7	1	1.218131	0.30453275
Total	15.143	1.616	22	4.283	4	1

MPC for Energy Consumption

MPC for proper residual pressure	Direct supply system from mains public or private.	Gravity distribution system	Pressurized distribution system (Hydro pneumatic pumping system).	Combined distribution system	EIGEN VALUE	NORMALISED EIGEN
Direct supply system from mains public or private.	1	0.1428	0.1428	0.1428	0.144745	0.03618625
Gravity distribution system	7	1	1	0.1428	0.877116	0.219279
Pressurized distribution system (Hydro pneumatic pumping system).	7	1	1	5	1.649866	0.4124665
Combined distribution system	7	7	0.2	1	1.328273	0.33206825
Total	22	9.1428	2.3428	6.2856	4	1.00

MPC for proper residual pressure

MPC for Ease of installation	Direct supply system from mains public or private.	Gravity distribution system	Pressurized distribution system (Hydro pneumatic pumping system).	Combined distribution system	EIGEN VALUE	NORMALISED EIGEN
Direct supply system from mains public or private.	1	0.1428	7	1	0.636875	0.15921871
Gravity distribution system	7	1	7	7	2.549313	0.63732809
Pressurized distribution system (Hydro pneumatic pumping system).	0.14	0.143	1	0.143	0.176798	0.04419949
Combined distribution system	1	0.143	7	1	0.637015	0.15925371
Total	9.14	1.4288	22	9.143	4.00	1

MPC for Ease of installation

MPC for Facility management	Direct supply system from mains public or private.	Gravity distribution system	Pressurized distribution system (Hydro pneumatic pumping system).	Combined distribution system	EIGEN VALUE	NORMALISED EIGEN
Direct supply system from mains public or private.	1	0.143	1	0.143	0.27821	0.07878478
Gravity distribution system	7	1	1	0.143	0.27821	0.07878478
Pressurized distribution system (Hydro pneumatic pumping system).	1	1	1	0.143	0.371943	0.10532851
Combined distribution system	7	7	7	1	2.602903	0.73710193
Total	16	9.143	10	1.429	3.53	1

MPC for Facility management

MPC for Reliability	Direct supply system from mains public or private.	Gravity distribution system	Pressurized distribution system (Hydro pneumatic pumping system).	Combined distribution system	EIGEN VALUE	NORMALISED EIGEN
Direct supply system from mains public or private.	1	0.1428	0.333	0.1428	0.20951	0.0523775
Gravity distribution system	7	1	1	0.1428	0.716644	0.179161
Pressurized distribution system (Hydro pneumatic pumping system).	3	1	1	0.166	0.510404	0.127601
Combined distribution system	7	7	6	1	2.563442	0.6408605
Total	18	9.1428	8.333	1.4516	4	1

MPC for Reliability

MPC for parameters	Energy Consumption	Proper residual pressure	Ease of installation	Facility Management	Reliability	EIGEN VALUE	NORMALISED EIGEN
Energy Consumption	1	1	7	1	7	1.581835	0.3085933
Proper residual pressure	1	1	7	1	1	1.130231	0.2204919
Ease of installation	0.1428	0.1428	1	1.666	1.66	0.551371	0.1075646
Facility Management	1	1	6	1	1	1.093194	0.2132665
Reliability	0.1428	1	6	1	1	0.769322	0.1500837
Total	3.2856	4.1428	27	5.666	11.66	5.13	1

MPC for parameter

Final MADA Table for the desirability of techniques:

MADA for Types of water supply system

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	Energy Consumption	Proper residual pressure	Ease of installation	Facility Management	Reliability	Final Desirability	RANKING
Weightages	**0.308593**	**0.22049**	**0.1075646**	**0.21327**	**0.1500837**		
Direct supply system from mains public or private.	0.126524	0.03619	0.159219	0.07879	0.052378		
	0.039044	0.00798	0.0171263	0.0168	0.0078611	0.088813	4
Gravity distribution system	0.524924	0.21928	0.637328	0.78785	0.179161		
	0.161988	0.04835	0.0685539	0.16802	0.0268891	0.473802	1
Pressurized distribution system (Hydro pneumatic pumping system).	0.044019	0.41247	0.044199	0.10533	0.127601		
	0.013584	0.09095	0.0047542	0.02246	0.01915083	0.15089783	3
Combined distribution system	0.304533	0.33207	0.159254	0.7371	0.640861		
	0.093977	0.07322	0.0171301	0.1572	0.09618279	0.43770719	2

Hence we see that the best system of Water supply system is Gravity distribution system, as it ranks 1st. The next desirable option is Combined distribution system, and the third is Pressurized distribution system (Hydro pneumatic pumping system).

(ii) Types of piping system.

MPC for Ease of Installation							
	Single stack system	One pipe Partially ventilated system	One pipe Fully ventilated system	Two pipe system with common vent pipes	Two pipe system with independent vent pipe	EIGEN VALUE	NORMALISED EIGEN
Single stack system	1	0.2	0.1428	0.2	0.143	0.174517	0.03491
One pipe Partially ventilated system	5	1	0.2	0.14	0.111	0.347094	0.069433
One pipe Fully ventilated system	7	5	1	0.14	0.111	0.653337	0.130694
Two pipe system with common vent pipe	5	7	7	1	0.143	1.131502	0.226346
Two pipe system with independent vent pipe	7	9	9	7	1	2.692542	0.538617
Total	25	22.2	17.343	8.49	1.508	4.998992	1

MPC for Ease of Installation

MPC for Ease of Integration							
	Single stack system	One pipe Partially ventilated system	One pipe Fully ventilated system	Two pipe system with common vent pipes	Two pipe system with independent vent pipe	EIGEN VALUE	NORMALISED EIGEN
Single stack system	1	0.33	0.2	0.14	0.111	0.159084	0.031817
One pipe Partially ventilated system	3	1	0.33	0.2	0.143	0.313902	0.06278
One pipe Fully ventilated system	5	3	1	0.11	0.143	0.546061	0.109212
Two pipe system with common vent pipe	7	5	9	1	0.111	1.26882	0.253764
Two pipe system with independent vent pipe	9	7	7	9	1	2.712133	0.542427
Total	25	16.3	17.53	10.5	1.508	5	1

MPC for Ease of Integration

MPC for Facility Management							
	Single stack system	One pipe Partially ventilated system	One pipe Fully ventilated system	Two pipe system with common vent pipes	Two pipe system with independent vent pipe	EIGEN VALUE	NORMALISED EIGEN
Single stack system	1	0.33	0.2	0.14	0.111	0.162073	0.032415
One pipe Partially ventilated system	3	1	0.33	0.2	0.143	0.318351	0.06367
One pipe Fully ventilated system	5	3	1	0.14	0.111	0.531211	0.106242
Two pipe system with common vent pipe	7	5	7	1	0.143	1.198067	0.239613
Two pipe system with independent vent pipe	9	7	9	7	1	2.790297	0.55806
Total	25	16.3	17.53	8.49	1.508	5.00	1

MPC for Facility Management

MPC for performance							
	Single stack system	One pipe Partially ventilated system	One pipe Fully ventilated system	Two pipe system with common vent pipes	Two pipe system with independent vent pipe	EIGEN VALUE	NORMALISED EIGEN
Single stack system	1	0.33	0.2	0.14	0.111	0.159077	0.031815
One pipe Partially ventilated system	3	1	0.333	0.2	0.143	0.314064	0.062813
One pipe Fully ventilated system	5	3	1	0.11	0.143	0.546044	0.109209
Two pipe system with common vent pipe	7	5	9	1	0.111	1.268794	0.253759
Two pipe system with independent vent pipe	9	7	7	9	1	2.71202	0.542404
Total	25	16.3	17.533	10.5	1.508	5.00	1

MPC for performance

MPC for Cost							
	Single stack system	One pipe Partially ventilated system	One pipe Fully ventilated system	Two pipe system with common vent pipes	Two pipe system with independent vent pipe	EIGEN VALUE	NORMALISED EIGEN
Single stack system	1	1	2	3	4	1.575022	0.315004
One pipe Partially ventilated system	1	1	1	2	3	1.191025	0.238205
One pipe Fully ventilated system	0.5	1	1	4	5	1.3474	0.26948
Two pipe system with common vent pipe	0.333	0.5	0.25	1	3	0.578915	0.115783
Two pipe system with independent vent pipe	0.25	0.33	0.2	0.33	1	0.307638	0.061528
Total	3.083	3.83	4.45	10.3	16	5	1

MPC for Cost

MPC for parameter							
	Ease of installation	Facility Management	Performance	Ease of integration	Cost	EIGEN VALUE	NORMALISED EIGEN
Ease of installation	1	0.2	0.1428	0.14	1	0.2142	0.04284
Facility Management	5	1	1	0.2	1	0.858334	0.171667
Performance	7	1	1	5	8	2.124703	0.424941
Ease of integration	7	5	0.2	1	5	1.489473	0.297895
Cost	1	1	0.125	0.2	1	0.313291	0.062658
Total	21	8.2	2.4678	6.54	16	5.00	1

MPC for parameter

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Final MADA Table for the desirability of techniques:

MADA for Types of pipping system

	Ease of installation	Facility Management	performance	Ease of integration	Cost	FINAL DESIRABILITY	RANKING
weightages	0.0428	0.17	0.4249	0.3	0.063		
Single stack system	0.0349	0.03	0.0318	0.03	0.315		
	0.0015	0.01	0.0135	0.01	0.02	0.049795	5
One pipe Partially ventilated system	0.0694	0.06	0.0628	0.06	0.238		
	0.003	0.01	0.0267	0.02	0.015	0.074225	4
One pipe Fully ventilated system	0.1307	0.11	0.1092	0.11	0.269		
	0.0056	0.02	0.0464	0.03	0.017	0.119663	3
Two pipe system with common vent pipe	0.2263	0.24	0.2538	0.25	0.116		
	0.0097	0.04	0.1078	0.08	0.007	0.241513	2
Two pipe system with independent vent pipe	0.5386	0.56	0.5424	0.54	0.062		
	0.0231	0.1	0.2305	0.16	0.004	0.514806	1

Hence, we see that the best system of piping system isTwo pipe system with independent vent pipe, as it ranks 1st. The next desirable option is Two pipe system with common vent pipe system, and the third is One pipe fully ventilated system.

(iii)Efficiency improvement of motors and pumps.

MPC for Ease of integration	Centrifugal pump	Rotary pump	Reciprocating pump	EIGEN VALUE	NORMALISED EIGEN
Centrifugal pump	1	7	7	2.1042	0.70139
Rotary pump	0.14	1	0.143	0.1953	0.06509
Reciprocating pump	0.143	7	1	0.7006	0.23352
TOTAL	1.286	15	8.143	3	1

MPC for Ease of integration

MPC for Ease of installation	Centrifugal pump	Rotary pump	Reciprocating pump	EIGEN VALUE	NORMALISED EIGEN
Centrifugal pump	1	1	0.2	0.5671	0.18903
Rotary pump	1.00	1	1	0.9307	0.31025
Reciprocating pump	5	1	1	1.5022	0.50072
TOTAL	7	3	2.2	3	1

MPC for Ease of installation

MPC for Energy efficiency	Centrifugal pump	Rotary pump	Reciprocating pump	EIGEN VALUE	NORMALISED EIGEN
Centrifugal pump	1	0.2	0.2	0.266	0.08867
Rotary pump	5.00	1	0.2	0.7587	0.2529
Reciprocating pump	5	5	1	1.9753	0.65843
TOTAL	11	6.2	1.4	3	1

MPC for Energy efficiency

MPC for performance	Centrifugal pump	Rotary pump	Reciprocating pump	EIGEN VALUE	NORMALISED EIGEN
Centrifugal pump	1	7	7	2.2542	0.75141
Rotary pump	0.14	1	0.333	0.2419	0.08065
Reciprocating pump	0.143	3	1	0.5038	0.16794
TOTAL	1.286	11	8.333	3	1

MPC for performance

MPC for Cost	Centrifugal pump	Rotary pump	Reciprocating pump	EIGEN VALUE	NORMALISED EIGEN
Centrifugal pump	1	7	7	2.3334	0.7778
Rotary pump	0.14	1	1	0.3333	0.1111
Reciprocating pump	0.143	1	1	0.3333	0.1111
TOTAL	1.286	9	9	3	1

MPC for Cost

MPC for parameters	Cost	Energy efficiency	performance	Ease of integration	Ease of installation	EIGEN VALUE	NORMALISED EIGEN
Cost	1	1	1	1	5	1.107279	0.221456
Energy efficiency	1.00	1	1	5	5	1.390108	0.278022
performance	1	1	1	7	7	1.611523	0.322305
Ease of integration	1	0.2	0.143	1	7	0.691089	0.138218
Ease of installation	0.2	0.2	0.143	0.1428	1	0.200002	0.04
TOTAL	4.2	3.4	3.286	14.143	25	5.00	1

MPC for parameters

International Journal of Engineering Research & Technology (IJERT)
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Vol. 10 Issue 01, January-2021

Final MADA Table for the desirability of techniques:

MADA for Motors & pumps

	Cost	Energy efficiency	performance	Ease of integration	Ease of installation	FINAL DESIRABILITY	RANKING
Weightages	**0.221**	**0.278**	**0.322**	**0.1382**	**0.04**		
Centrifugal pump	**0.78**	**0.8867**	**0.751**	**0.7014**	**0.18903**		
	0.172	0.2465	0.242	0.0969	0.00756	**0.76546**	**1**
Rotary pump	**0.111**	**0.2529**	**0.081**	**0.0651**	**0.31025**		
	0.025	0.0703	0.026	0.009	0.01241	**0.142316**	**2**
Reciprocating pump	**0.111**	**0.6584**	**0.168**	**0.2335**	**0.50072**		
	0.025	0.1831	0.054	0.0323	0.02003	**0.314095**	**3**

Hence, we see that the best system for is Centrifugal pump, as it ranks 1st. The next desirable option is Rotary pump, and the third is Reciprocating pump.

(iv) Fixtures

MPC for Ease of installation	Sensor	Water efficient fixture	Auto control valve	Pressure reducing valves	EIGEN VALUE	NORMALISED EIGEN
Sensor	1	0.143	0.2	0.143	0.185177	0.04629
Water efficient fixture	7.00	1	7	3	2.130442	0.53261
Auto control valve	5	0.14	1	0.143	0.435949	0.10899
Pressure reducing valves	7	0.33	7	1	1.248432	0.31211
TOTAL	20	1.613	15.2	4.286	4	1

MPC for Ease of installation

MPC for Rate of flow	Sensor	Water efficient fixture	Auto control valve	Pressure reducing valves	EIGEN VALUE	NORMALISED EIGEN
Sensor	1	0.143	0.2	0.143	0.183928	0.04598
Water efficient fixture	7	1	7	5	2.341521	0.58538
Auto control valve	5	0.143	1	0.2	0.45352	0.11338
Pressure reducing valves	7	0.2	5	1	1.021031	0.25526
TOTAL	20	1.486	13.2	6.343	4	1

MPC for Rate of flow

MPC for cost	Sensor	Water efficient fixture	Auto control valve	Pressure reducing valves	EIGEN VALUE	NORMALISED EIGEN
Sensor	1	0.143	0.2	0.143	0.183928	0.04598
Water efficient fixture	7	1	7	5	2.341521	0.58538
Auto control valve	5	0.143	1	0.2	0.45352	0.11338
Pressure reducing valves	7	0.2	5	1	1.021031	0.25526
TOTAL	20	1.486	13.2	6.343	4	1

MPC for Maintenance

MPC for Maintenance	Sensor	Water efficient fixture	Auto control valve	Pressure reducing valves	EIGEN VALUE	NORMALISED EIGEN
Sensor	1	0.143	0.2	0.143	0.183928	0.04598
Water efficient fixture	7	1	7	5	2.341521	0.58538
Auto control valve	5	0.143	1	0.2	0.45352	0.11338
Pressure reducing valves	7	0.2	5	1	1.021031	0.25526
TOTAL	20	1.486	13.2	6.343	4	1

MPC for Cost

MPC for proper residual pressure	Sensor	Water efficient fixture	Auto control valve	Pressure reducing valves	EIGEN VALUE	NORMALISED EIGEN
Sensor	1	0.143	0.2	0.143	0.183928	0.04598
Water efficient fixture	7	1	7	5	2.341521	0.58538
Auto control valve	5	0.143	1	0.2	0.45352	0.11338
Pressure reducing valves	7	0.2	5	1	1.021031	0.25526
TOTAL	20	1.486	13.2	6.343	4	1

MPC for proper residual pressure

MPC for parameter	Rate o flow	Ease of installation	Maintenance	Cost	Proper residual pressure	EIGEN VALUE	NORMALISED EIGEN
Rate of flow	1	5	0.143	3	1	0.8605	0.1721
Ease of installation	0.2	1	0.143	0.2	0.2	0.19451	0.038901
Maintenance	7	7	1	7	1	2.17678	0.435356
Cost	0.33	5	0.143	1	0.2	0.43144	0.086289
Proper residual pressure	1	5	1	5	1	1.33678	0.267355
TOTAL	9.53	23	2.429	16.2	3.4	5	1

MPC for parameter

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Final MADA Table for the desirability of techniques:

MADA for Fixture

	Rate o flow	Ease of installation	Maintenance	Cost	Proper residual pressure	Final Desirability	RANKING
Weightages	**0.1721**	**0.0389**	**0.4354**	**0.086**	**0.267355**		
	0.04598	**0.0463**	**0.046**	**0.046**	**0.04598**		
sensor	0.007913	0.0018	0.02	0.004	0.012293	**0.04599**	**4**
	0.58538	**0.5326**	**0.5854**	**0.585**	**0.58538**		
water efficient fixture	0.100744	0.0207	0.2548	0.051	0.156504	**0.58332**	**1**
	0.11338	**0.109**	**0.1134**	**0.113**	**0.11338**		
Auto control valve	0.019513	0.0042	0.0494	0.01	0.030313	**0.11321**	**3**
	0.25526	**0.3121**	**0.2553**	**0.255**	**0.25526**		
pressure reducing valve	0.04393	0.0121	0.1111	0.022	0.068245	**0.25747**	**2**

Hence, we see that the best system for Fixture is Water efficient fixture, as it ranks 1st. The next desirable option is pressure reducing valve, and the third is Auto control valve.

(2) Landscaping

MPC for Design work	Minimising Lawn area	Maximise native and adapted species	Maximise tree/shrub plantation	Use of efficient technologies	Grouping of similar plant species as per the water requirement	Xeriscaping	EIGEN VALUE	NORMALISED EIGEN
Minimising Lawn area	1	0.33	0.33	0.33	0.25	0.25	0.330061	0.0550102
Maximise native and adapted species	3	1	3	1	3	1	1.471097	0.2451828
Maximise tree/shrub plantation	3	0.33	1	1	3	0.33	0.901081	0.1501801
Use of efficient technologies	3	1	1	1	2	1	1.158598	0.1930996
Grouping of similar plant species as per the water requirement	4	0.33	0.33	0.5	1	0.33	0.612511	0.1020851
Xeriscaping	4	1	3	1	3	1	1.526653	0.2544421
TOTAL	18	3.99	8.66	4.83	12.25	3.91	6.00	1

MPC for Design work

MPC for water efficiency	Minimising Lawn area	Maximise native and adapted species	Maximise tree/shrub plantation	Use of efficient technologies	Grouping of similar plant species as per the water requirement	Xeriscaping	EIGEN VALUE	NORMALISED EIGEN
Minimising Lawn area	1	0.33	0.33	0.33	1.00	0.33	0.423318	0.070553
Maximise native and adapted species	3	1	3	1	3	1	1.499457	0.2499095
Maximise tree/shrub plantation	3	0.333	1	1	2	0.333	0.862402	0.1437337
Use of efficient technologies	3	1	1	1	3	1	1.273034	0.2121723
Grouping of similar plant species as per the water requirement	1	0.333	0.5	0.33	1	0.333	0.442332	0.073722
Xeriscaping	3	1	3	1	3	1	1.499457	0.2499095
TOTAL	14	4.00	8.83	4.66	13.00	4.00	6	1

MPC for water efficiency

MPC for Maintenance	Minimising Lawn area	Maximise native and adapted species	Maximise tree/shrub plantation	Use of efficient technologies	Grouping of similar plant species as per the water requirement	Xeriscaping	EIGEN VALUE	NORMALISED EIGEN
Minimising Lawn area	1	0.33	0.33	0.33	0.25	0.25	0.32938	0.0548967
Maximise native and adapted species	3	1	3	1	3	1	1.481893	0.2469822
Maximise tree/shrub plantation	3	0.33	1	1	3	0.33	0.919143	0.1531905
Use of efficient technologies	3	1	1	1	2	1	1.162137	0.1936895
Grouping of similar plant species as per the water requirement	4	0.333	0.333	0.5	1	0.5	0.658888	0.1098147
Xeriscaping	4	1	3	1	2	1	1.448559	0.2414265
TOTAL	18	4.00	8.66	4.83	11.25	4.08	6	1

MPC for Maintenance

MPC for Life span	Minimising Lawn area	Maximise native and adapted species	Maximise tree/shrub plantation	Use of efficient technologies	Grouping of similar plant species as per the water requirement	Xeriscaping	EIGEN VALUE	NORMALISED EIGEN
Minimising Lawn area	1	0.33	0.33	0.33	0.25	0.25	0.331007	0.0551679
Maximise native and adapted species	3	1	3	1	3	1	1.517443	0.2529073
Maximise tree/shrub plantation	3	0.33	1	1	3	0.5	0.97111	0.1618517
Use of efficient technologies	3	1	1	1	2	1	1.167662	0.1946104
Grouping of similar plant species as per the water requirement	4	0.333	0.333	0.5	1	0.5	0.659112	0.109852
Xeriscaping	4	1	2	1	2	1	1.353664	0.2256107
TOTAL	18	3.99	7.67	4.83	11.25	4.25	5.999998	1

MPC for Life span

MPC for parameters	Design work	Water efficiency	Maintenance	Life span	EIGEN VALUE	NORMALISED EIGEN
Design work	1	0.33	0.33	0.50	0.41388	0.103
Water efficiency	3	1	3	3	1.8777	0.469
Maintenance	3	0.333	1	3	1.11462	0.279
Life span	2	0.333	0.333	1	0.5938	0.148
TOTAL	9	2.00	4.66	7.50	3.999999	1

MPC for parameter

Final MADA Table for the desirability of techniques:

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MADA for Landscape

	Design work	Water efficiency	Maintenance	Life span	FINAL DESIRABILITY	RANKING
WEIGHTAGES	**0.103**	**0.469**	**0.279**	**0.148**		
Minimising Lawn area	**0.05501**	**0.071**	**0.0549**	**0.055**		
	0.00567	0.033	0.0153	0.008	**0.062237**	**5**
Maximise native and adapted species	**0.24518**	**0.25**	**0.247**	**0.253**		
	0.02525	0.117	0.0689	0.037	**0.2488**	**1**
Maximise tree/shrub plantation	**0.15018**	**0.144**	**0.1532**	**0.162**		
	0.01547	0.067	0.0427	0.024	**0.149574**	**3**
Use of efficient technologies	**0.1931**	**0.212**	**0.1937**	**0.195**		
	0.01989	0.1	0.054	0.029	**0.20224**	**2**
Grouping of similar plant species as per the water requirement	**0.10209**	**0.074**	**0.1098**	**0.11**		
	0.01051	0.035	0.0306	0.016	**0.091987**	**4**
Xeriscaping	**0.25444**	**0.25**	**0.2414**	**0.226**		
	0.02621	0.117	0.0674	0.033	**0.244163**	**1**

Hence we see that the best system of Landscape is Maximise native and adapted species, Xeriscaping, as it ranks 1st. The next desirable option is Use of efficient technologies, and the third is Maximise tree/shrub plantation.

(3) Irrigation Practices

MPC for water efficiency	Micro-drip	Micro-spray	Multiple-sprinkler	Sprinkler, large gun	Smart irrigation system	Sub irrigation system	EIGEN VALUE	NORMALISED EIGEN
Micro-drip	1	0.33	0.33	0.50	0.33	1.00	0.4796	0.07993
Micro-spray	3	1	3	3	1	2	1.7558	0.29264
Multiple-sprinkler	3	0.333	1	3	1	1	1.1222	0.18703
Sprinkler, large gun	2	0.333	0.333	1	1	1	0.7346	0.12244
Smart irrigation system	3	1	1	1	1	1	1.1023	0.18371
Sub irrigation system	1	0.5	1	1	1	1	0.8055	0.13426
TOTAL	13	3.50	6.66	9.50	5.33	7.00	6	1

MPC for water efficiency

MPC for rate of flow	Micro-drip	Micro-spray	Multiple-sprinkler	Sprinkler, large gun	Smart irrigation system	Sub irrigation system	EIGEN VALUE	NORMALISED EIGEN
Micro-drip	1	0.33	0.33	0.50	0.33	1.00	0.4788	0.07979
Micro-spray	3	1	3	3	1	2	1.756	0.29267
Multiple-sprinkler	3	0.333	1	3	1	1	1.1223	0.18706
Sprinkler, large gun	2	0.333	0.333	1	1	1	0.7347	0.12245
Smart irrigation system	3	1	1	1	1	1	1.1025	0.18375
Sub irrigation system	1	0.5	1	1	1	1	0.8056	0.13427
TOTAL	13	3.50	6.66	9.50	5.33	7.00	6	1

MPC for rate of flow

MPC for cost	Micro-drip	Micro-spray	Multiple-sprinkler	Sprinkler, large gun	Smart irrigation system	Sub irrigation system	EIGEN VALUE	NORMALISED EIGEN
Micro-drip	1	0.33	0.33	0.50	0.33	1.00	0.4796	0.07993
Micro-spray	3	1	3	3	1	2	1.756	0.29267
Multiple-sprinkler	3	0.333	1	3	1	1	1.1222	0.18704
Sprinkler, large gun	2	0.333	0.33	1	1	1	0.7342	0.12237
Smart irrigation system	3	1	1	1	1	1	1.1023	0.18372
Sub irrigation system	1	0.5	1	1	1	1	0.8056	0.13427
TOTAL	13	3.50	6.66	9.50	5.33	7.00	6	1

MPC for cost

MPC for facility management	Micro-drip	Micro-spray	Multiple-sprinkler	Sprinkler, large gun	Smart irrigation system	Sub irrigation system	EIGEN VALUE	NORMALISED EIGEN
Micro-drip	1	0.33	0.33	0.50	0.33	1.00	0.48	0.08
Micro-spray	3	1	3	3	1	2	1.7556	0.2926
Multiple-sprinkler	3	0.333	1	3	1	1	1.1221	0.18702
Sprinkler, large gun	2	0.333	0.333	1	1	1	0.7346	0.12243
Smart irrigation system	3	1	1	1	1	1	1.1022	0.1837
Sub irrigation system	1	0.5	1	1	1	1	0.8055	0.1837
TOTAL	13	3.50	6.67	9.50	5.33	7.00	6	1.04946

MPC for facility management

MPC for payback period	Micro-drip	Micro-spray	Multiple-sprinkler	Sprinkler, large gun	Smart irrigation system	Sub irrigation system	EIGEN VALUE	NORMALISED EIGEN
Micro-drip	1	0.33	0.33	0.50	0.33	1.00	0.48	0.04306
Micro-spray	3	1	3	3	1	2	1.7556	0.15752
Multiple-sprinkler	3	0.333	1	3	1	1	1.1221	0.10068
Sprinkler, large gun	2	0.333	0.333	1	1	1	0.7346	0.06591
Smart irrigation system	3	1	1	1	1	1	6.2477	0.56056
Sub irrigation system	1	0.5	1	1	1	1	0.8055	0.07227
TOTAL	13	3.50	6.67	9.50	5.33	7.00	11.1455	1

MPC for payback period

MPC for parameter	Water efficiency	Rate of flow	Cost	Facility Management	Payback period	EIGEN VALUE	NORMALISED EIGEN
Water efficiency	1	3.00	3.00	3.00	3.00	2.1085	0.4217
Rate o flow	0.33	1	1	1	1	0.7014	0.1403
Cost	0.33	1	1	1	0.5	0.6194	0.1239
Facility Management	0.33	1	1	1	0.5	0.6194	0.1239
Payback period	0.33	1	2	2	1	0.9514	0.1903
TOTAL	2.33	7.00	8.00	8.00	6.00	5.00	1

MPC for parameter

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Final MADA Table for the desirability of techniques:

MADA for Irrigation practices (Irrigation practices)

	Water efficiency	Rate of flow	Cost	Facility Management	Payback period	FINAL DESIRABILITY	RANKING
Weightage	**0.42**	**0.14**	**0.1239**	**0.1239**	**0.1903**		
Micro-drip	**0.08**	**0.08**	**0.08**	**0.08**	**0.04**		
	0.03	0.01	0.01	0.01	0.01	**0.0729**	**5**
Micro-spray	**0.29**	**0.293**	**0.2927**	**0.2926**	**0.1575**		
	0.12	0.041	0.0363	0.0363	0.03	**0.267**	**1**
Multiple-sprinkler	**0.19**	**0.187**	**0.187**	**0.187**	**0.1007**		
	0.08	0.026	0.0232	0.0232	0.0192	**0.1706**	**2**
Sprinkler, large gun	**0.12**	**0.122**	**0.1224**	**0.1224**	**0.0659**		
	0.05	0.017	0.0152	0.0152	0.0125	**0.1117**	**4**
Smart irrigation system	**0.18**	**0.184**	**0.1837**	**0.1837**	**0.5606**		
	0.08	0.026	0.0228	0.0228	0.1067	**0.255**	**1**
Sub irrigation system	**0.13**	**0.13**	**0.13**	**0.18**	**0.07**		
	0.06	0.019	0.0166	0.0228	0.0138	**0.128605**	**3**

Hence we see that the best system of Irrigation practices is Micro spray and smart irrigation system, as it ranks 1st. The next desirable option is Multiple-sprinkler, and the third is sub irrigation system.

4 (i) Rainwater recharge structure

MPC for Ease of construction	Recharge pit	Recharge trenches	Reuse of abandoned dug wells	Recharge shafts	Lateral shaft with bore wells	Deep injection well	EIGEN VALUE	NORMALISED EIGEN
Recharge pit	1	9.00	8.00	9.00	8.00	8.00	2.677327	0.4462211
Recharge trenches	0.1111	1	9	9	9	8	1.439571	0.2399285
Reuse of abandoned dug wells	0.125	0.111	1	8	8	8	0.86188	0.1436466
Recharge shafts	0.1111	0.111	0.125	1	8	8	0.548678	0.0914463
Lateral shaft with bore wells	0.125	0.1111	0.125	0.125	1	9	0.343877	0.0573128
Deep injection well	0.125	0.125	0.125	0.125	0.11 1	1	0.128668	0.0214447
TOTAL	1.5972	10.46	18.38	27.25	34.1 1	42.00	6.000001	1

MPC for Ease of construction

MPC for Maintenance	Recharge pit	Recharge trenches	Reuse of abandoned dug wells	Recharge shafts	Lateral shaft with bore wells	Deep injection well	EIGEN VALUE	NORMALISED EIGEN
Recharge pit	1	9.00	8.00	7.00	7.00	8.00	2.595788	0.4326314
Recharge trenches	0.1111	1	9	9	8	7	1.436081	0.2393469
Reuse of abandoned dug wells	0.125	0.1111	1	7	8	9	0.890759	0.1484599
Recharge shafts	0.1428	0.1111	0.1428	1	9	8	0.613161	0.1021935
Lateral shaft with bore wells	0.1428	0.125	0.125	0.111	1	8	0.335327	0.0558878
Deep injection well	0.125	0.1428	0.111	0.125	0.125	1	0.128883	0.0214805
TOTAL	1.6467	10.49	18.38	24.24	33.13	41.00	5.999999	1

MPC for Maintenance

MPC for Improve quality of ground water	Recharge pit	Recharge trenches	Reuse of abandoned dug wells	Recharge shafts	Lateral shaft with bore wells	Deep injection well	EIGEN VALUE	NORMALISED EIGEN
Recharge pit	1	8.00	7.00	7.00	7.00	8.00	2.540368	0.4233947
Recharge trenches	0.125	1	9	9	9	8	1.538432	0.2564053
Reuse of abandoned dug wells	0.1428	0.111	1	7	7	7	0.827468	0.1379113
Recharge shafts	0.1428	0.111	0.1428	1	8	9	0.609663	0.1016105
Lateral shaft with bore wells	0.1428	0.1111	0.1428	0.1428	1	9	0.356337	0.0593895
Deep injection well	0.125	0.125	0.1428	0.1111	0.111	1	0.127732	0.0212887
TOTAL	1.6784	9.46	17.43	24.25	32.11	42.00	6	1

MPC for Improve quality of ground water

MPC for Costing	Recharge pit	Recharge trenches	Reuse of abandoned dug wells	Recharge shafts	Lateral shaft with bore wells	Deep injection well	EIGEN VALUE	NORMALISED EIGEN
Recharge pit	1	7.00	8.00	9.00	9.00	8.00	2.673108	0.445518
Recharge trenches	0.1428	1	8	9	9	9	1.456145	0.2426908
Reuse of abandoned dug wells	0.125	0.125	1	8	8	8	0.85112	0.1418533
Recharge shafts	0.111	0.111	0.125	1	9	9	0.584229	0.0973715
Lateral shaft with bore wells	0.111	0.1111	0.125	0.1111	1	8	0.306878	0.0511463
Deep injection well	0.125	0.111	0.125	0.111	0.125	1	0.12852	0.02142
TOTAL	1.6148	8.46	17.38	27.22	36.13	43.0 0	6	1

MPC for costing

MPC for Reduces run-off								
	Recharge pit	Recharge trenches	Reuse of abandoned dug wells	Recharge shafts	Lateral shaft with bore wells	Deep injection well	EIGEN VALUE	NORMALISED EIGEN
Recharge pit	1	8.00	8.00	7.00	7.00	8.00	2.575809	0.4293015
Recharge trenches	0.125	1	9	9	8	7	1.454019	0.2423365
Reuse of abandoned dug wells	0.125	0.111	1	7	8	9	0.891267	0.1485445
Recharge shafts	0.1428	0.111	0.1428	1	9	9	0.637809	0.1063015
Lateral shaft with bore wells	0.1428	0.125	0.125	0.111	1	7	0.311453	0.0519088
Deep injection well	0.125	0.142 8	0.111	0.111	0.142 8	1	0.129643	0.0216072
TOTAL	1.6606	9.49	18.38	24.22	33.14	41.00	6	1

MPC for Reduce run-off

MPC for parameter							
	Improve quality of groundwater	Reduces run-off	Ease of construction	Costing	Maintenance	EIGEN VALUE	NORMALISED EIGEN
Improve quality of groundwater	1	9.00	7.00	7.00	7.00	2.4827	0.496541
Reduces run-off	0.111	1	8	8	8	1.2721	0.254414
Ease of construction	0.1428	0.125	1	7	7	0.702	0.140404
Costing	0.1428	0.125	0.1428	1	7	0.3901	0.078025
Maintenance	0.1428	0.125	0.1428	0.1428	1	0.1531	0.030617
TOTAL	1.5394	10.38	16.29	23.14	30.00	5.00	1

MPC for parameter

Final MADA Table for the desirability of techniques:

MADA for Rainwater structure

	Improve quality of groundwater	Reduces run-off	Ease of construction	Costing	Maintenance	Final desirability	RANKING
Weightages	**0.49654**	**0.25441**	**0.1404**	**0.07803**	**0.03062**		
Recharge pit	**0.4234**	**0.43**	**0.45**	**0.45**	**0.43**		
	0.21023	0.11	0.06	0.03	0.01	**0.4301**	**1**
Recharge trenches	**0.25641**	**0.24234**	**0.2399**	**0.24269**	**0.23935**		
	0.12732	0.06165	0.0337	0.01894	0.00733	**0.2489**	**2**
Reuse of abandoned dug wells	**0.13791**	**0.14855**	**0.1436**	**0.14853**	**0.14846**		
	0.06848	0.03779	0.0202	0.01159	0.00455	**0.1426**	**3**
Recharge shafts	**0.10161**	**0.1063**	**0.0914**	**0.09737**	**0.10219**		
	0.05045	0.02704	0.0128	0.0076	0.00313	**0.1011**	**4**
Lateral shaft with bore wells	**0.05939**	**0.05191**	**0.0573**	**0.05115**	**0.05589**		
	0.02949	0.01321	0.008	0.00399	0.00171	**0.0564**	**5**
Deep injection well	**0.02129**	**0.02**	**0.02**	**0.02**	**0.02**		
	0.0106	0.0055	0.003	0.0017	0.0007	**0.0214**	**6**

Hence we see that the best system of Rainwater structure is Recharge pit, as it ranks 1st. The next desirable option is Recharge trenches, and the third is Reuse of abandoned dug wells.

4 (ii) Filters in RWH

MPC for Amount of silt load								
	Cloth filter	Sand filter	Reverse sand filter	Dewas filter	Varun filter	Desilting chambers	EIGEN VALUE	NORMALISED EIGEN
Cloth filter	1	0.11	0.13	0.13	0.14	0.14	0.140824	0.0234707
Sand filter	9	1	0.1428	0.1428	0.111	0.111	0.345719	0.0576198
Reverse sand filter	8	8	1	0.125	0.125	0.1428	0.574698	0.095783
Dewas filter	8	8	8	1	0.1428	0.1428	0.918392	0.1530653
Varun filter	7	9	8	7	1	0.1428	1.377915	0.2296525
Desilting chambers	7	9	7	8	8	1	2.642452	0.4404087
TOTAL	40	35.11	24.27	16.39	9.52	1.68	6	1

MPC for Amount of silt load

Quality of Run-off								
	Cloth filter	Sand filter	Reverse sand filter	Dewas filter	Varun filter	Desilting chambers	EIGEN VALUE	NORMALISED EIGEN
Cloth filter	1	0.11	0.13	0.13	0.14	0.14	0.142666	0.0237777
Sand filter	9	1	0.125	0.125	0.1111	0.1111	0.345406	0.0575677
Reverse sand filter	8	8	1	0.125	0.125	0.1428	0.576566	0.0960943
Dewas filter	8	8	8	1	0.1428	0.125	0.909721	0.1516202
Varun filter	7	9	8	7	1	0.125	1.36964	0.2282733
Desilting chambers	7	9	7	8	8	1	2.656001	0.4426668
TOTAL	40	35.11	24.25	16.38	9.52	1.65	6	1

MPC for Quality of Run-off

MPC for Costing								
	Cloth filter	Sand filter	Reverse sand filter	Dewas filter	Varun filter	Desilting chambers	EIGEN VALUE	NORMALISED EIGEN
Cloth filter	1	0.11	0.11	0.13	0.13	0.14	0.139385	0.0232322
Sand filter	9	1	0.1428	0.125	0.125	0.111	0.338609	0.0564381
Reverse sand filter	9	7	1	0.111	0.125	0.125	0.560059	0.0933486
Dewas filter	8	8	9	1	0.1428	0.1428	0.941723	0.156963
Varun filter	8	8	8	7	1	0.125	1.373485	0.2289275
Desilting chambers	7	9	8	7	8	1	2.64639	0.4410907
TOTAL	42	33.11	26.25	15.36	9.52	1.65	5.999651	1

MPC for Costing

MPC for Catchment Area								
	Cloth filter	Sand filter	Reverse sand filter	Dewas filter	Varun filter	Desilting chambers	EIGEN VALUE	NORMALISED EIGEN
Cloth filter	1	0.11	0.13	0.13	0.14	0.14	0.142671	0.0237785
Sand filter	9	1	0.125	0.125	0.111	0.111	0.345339	0.0575565
Reverse sand filter	8	8	1	0.125	0.125	0.1428	0.576572	0.0960953
Dewas filter	8	8	8	1	0.1428	0.125	0.909726	0.151621
Varun filter	7	9	8	7	1	0.125	1.369646	0.2282743
Desilting chambers	7	9	7	8	8	1	2.656046	0.4426743
TOTAL	40	35.11	24.25	16.38	9.52	1.65	6	1

MPC for Catchment area

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MPC for Type of recharge structure								
	Cloth filter	Sand filter	Reverse sand filter	Dewas filter	Varun filter	Desilting chambers	EIGEN VALUE	NORMALISED EIGEN
Cloth filter	1	0.11	0.11	0.13	0.13	0.14	0.139385	0.0232308
Sand filter	9	1	0.1428	0.125	0.125	0.111	0.338609	0.0564348
Reverse sand filter	9	7	1	0.111	0.125	0.125	0.560059	0.0933432
Dewas filter	8	8	9	1	0.1428	0.1428	0.941723	0.1569538
Varun filter	8	8	8	7	1	0.125	1.373485	0.2289142
Desilting chambers	7	9	8	7	8	1	2.646739	0.4411232
TOTAL	42	33.11	26.25	15.36	9.52	1.65	6	1

MPC for Type of recharge structure

MPC for parameter							
	Amount of silt load	Quality of Run-off	Catchment Area	Cost	Type of structure	EIGEN VALUE	NORMALISED EIGEN
Amount of silt load	1	0.11	0.11	0.13	0.13	0.136474	0.027295
Quality of Run-off	9	1	0.125	0.125	0.125	0.401306	0.080261
Catchment Area	9	8	1	0.1428	0.125	0.735855	0.147171
Cost	8	8	7	1	0.125	1.168094	0.233619
Type of structure	8	8	8	8	1	2.558271	0.511654
TOTAL	35	25.11	16.24	9.39	1.50	5.00	1

MPC for parameter

Final MADA Table for the desirability of techniques:
(MADA for Filters in Rainwater structure)

	Amount of silt load	Quality of Run-off	Catchment Area	Cost	Type of structure	Final Desirability	Ranking
Weightages	**0.027295**	**0.080261**	**0.147171**	**0.233619**	**0.511654**		
Cloth filter	**0.023471**	**0.24**	**0.02**	**0.23**	**0.02**		
	0.0006406	0.02	0.00	0.05	0.01	**0.089386**	**6**
Sand filter	**0.05762**	**0.057568**	**0.575565**	**0.56438**	**0.056435**		
	0.0015727	0.0046205	0.0847065	0.1318499	0.0288752	**0.251625**	**2**
Reverse sand filter	**0.095783**	**0.096094**	**0.096095**	**0.093349**	**0.093343**		
	0.0026144	0.0077126	0.0141424	0.0218081	0.0477593	**0.094037**	**5**
Dewas filter	**0.153065**	**0.15162**	**0.151621**	**0.156963**	**0.156954**		
	0.0041779	0.0121692	0.0223142	0.0366695	0.0803061	**0.155637**	**4**
Varun filter	**0.229653**	**0.228273**	**0.228274**	**0.228928**	**0.228914**		
	0.0062684	0.0183214	0.0335953	0.0534819	0.1171248	**0.228792**	**3**
Desilting chambers	**0.440409**	**0.44**	**0.44**	**0.44**	**0.44**		
	0.012021	0.035529	0.065149	0.103047	0.225702	**0.441448**	**1**

Hence we see that the best system for filter in Rainwater structure is Distillation chambers, as it ranks 1st. The next desirable option is Sand filter, and the third is Varun filter.

CONCLUSIONS

The major conclusions that can be drawn from this research work are as follows:
The basis of any water efficiency system has been detailed out and can be calculated initially using the benchmarks.
The potential fields of water savings have been analysed and worked out, by applying different permutations and combinations of various techniques.

RECOMMENDATION

The research work can be used to study and analyze the building's water efficiency performance, the performance of water supply system, different techniques in different scenarios and can be applied to any building.
Also, there is a strong need to make conscious decisions for choosing the optimum solution/option for water efficiency.

FUTURE SCOPE

The future scope for this research work is as follows –
The same categories can be done for high-rise building by applying the different technique in order to achieve the efficiency.
Similarly, the case study can be carried out for other types of buildings, namely, residential, hospital, hotels, etc.

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