

EFFECTIVENESS OF DRAINAGE SYSTEM IN BIRENDRANAGAR MUNICIPALITY OF SURKHET DISTRICT, NEPAL

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ABSTRACT

The study aims to assess the problem and impact of drainage system, through mixed method approach in Birendranagar municipality of surkhhet district. Primary data were collected from field observation, in-depth interview, focused group discussion and questionnaire survey. Altogether 110 samples were taken for questionnaire survey from targeted respondents. The collected data were for analyzed in excel, using RII formula for likert scale questions. It is clear that the major problem in the municipality improper planning and old drainage network. The designed is outdated driving flash flood in monsoon due to limited capacity and clogging issues in the drainage network. The increasing urban population with limited capacity of drainage network is driving the problem of water logging conditions and flash floods in city. The water logging has decreased the life of city roads leading pot holes and cracking. This has led to road interruption and traffic jam driving accidents in the city.

Keywords: *Drainage network, urban population, design limitation, water logging*

1. INTRODUCTION

Urban drainage systems have evolved significantly over the past decades, with international standards and best practices shaping their development and implementation. Modern urban drainage infrastructure encompasses complex networks of pipes, channels, and treatment facilities designed to manage stormwater and wastewater effectively. The International Water Association (IWA) has established comprehensive guidelines that emphasize sustainable urban drainage systems (SUDS), incorporating both grey and green infrastructure solutions [1]. These standards focus on three primary objectives: flood prevention, water quality improvement, and environmental protection. The United States has made significant strides in implementing sustainable urban drainage systems (SUDS) across its major metropolitan areas. In recent years, American cities have adopted comprehensive approaches to stormwater management, incorporating both traditional infrastructure and innovative solutions [2]. Emerging regional economic hubs grapple with combined pressures, evaluating the actual structural and operational capacity of existing stormwater infrastructure has become a critical step toward ensuring urban climate resilience [3]. Similarly, European cities have emerged as global leaders in sustainable drainage system implementation, with particular emphasis on green infrastructure solutions. The European Union's Water Framework Directive has provided a comprehensive framework for water management, encouraging member states to adopt innovative approaches to urban drainage. Cities across Europe have embraced nature-based solutions, incorporating rain gardens, permeable pavements, and green roofs into their urban fabric. Following Nepal Karnali Province Birendranagar Municipality designation as the provincial capital, the municipality experienced an unprecedented influx of migration and a corresponding 700% expansion of built-up urban cover over the past few decades [4]. Currently, Birendranagar lacks a comprehensive, dedicated municipal drainage master plan; instead, it relies heavily on rudimentary, uncovered stone-masonry roadside conduits [5]. Haphazard road construction and widespread solid waste mismanagement mean that plastic debris and household refuse frequently clog critical transit junctions and outlets, leading to severe localized blockages in Birendranagar drainage network [6].

2. MATERIALS AND METHODS

The research problem was identified, data were collected through primary and secondary survey. Both qualitative and quantitative data have been used. The total sample were 110. Collected data were analysed and interpreted using RII method.

2.1 Study Site

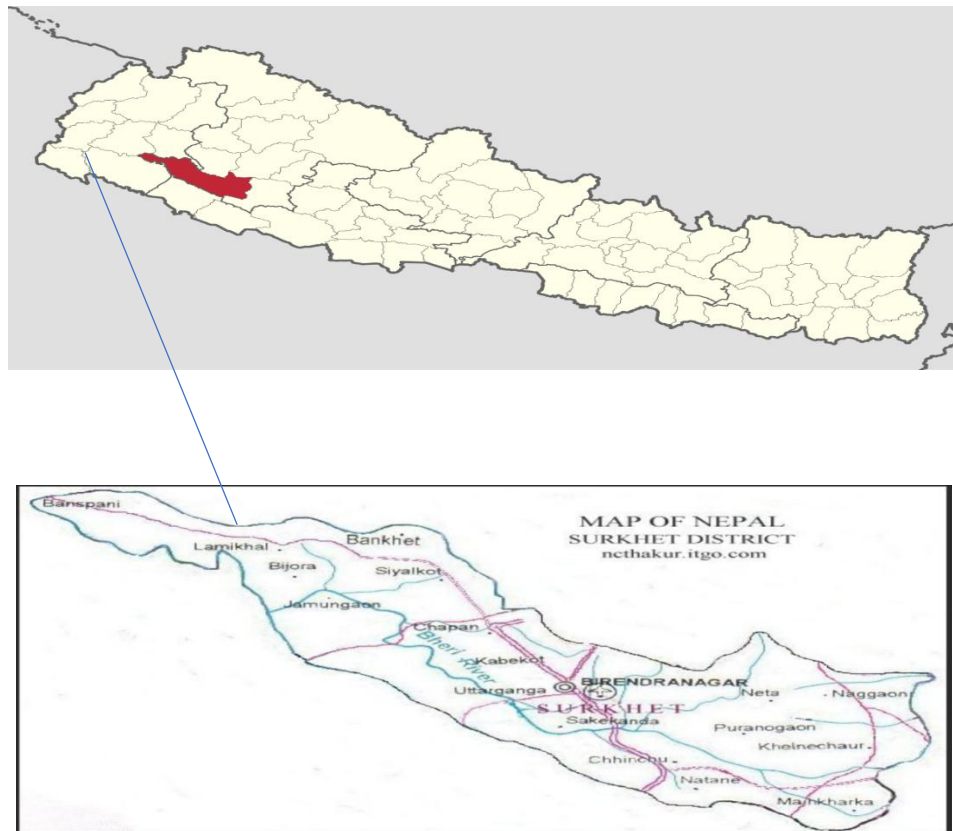


Fig. 2.1. Map of study site

2.2 Data Collection Methods

Data were collected using the tools such as field observation, in depth interview and focus group discussion. The study was conducted for four months during the period from first week of December 2024 to end of March 2025. Primary data were collected from Field observation, In-depth interview, focused group discussion and questionnaire survey.

2.4 Method of Data analysis

The collected data from questionnaire survey were analyzed using MS tool, Xcel. For the questions generated in Likert-5 point scale, RII was used to analyze the data. In this study, the value of RII is given by the equation:

$$\begin{aligned} \text{Relative Importance Index (RII)} &= (\sum W)/AN & \text{Equation (1)} \\ &= (5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1)/5N \end{aligned}$$

Where, W = weight to each factor by the respondent ranging from 1 to 5

n_1 = number of respondents who strongly disagree

n_2 = number of respondents who disagree

n_3 = number of respondents moderately agree or remain neutral

n_4 = number of respondents who agree

n_5 = number of respondents who strongly agree

A= highest weight i.e. 5 in this study

N= total number of respondents

The relative importance index (RII) value ranges from 0 to 1.

The analyzed data were further presented bar graphs, pie charts and later interpreted to achieve the desired objectives of the research.

3. RESULTS AND DISCUSSION

3.1 Results from Questionnaire Survey

3.1.1 Education of the Respondents

Out of 110 respondents, 23% of them have completed bachelor's level of education, 32% of them have completed secondary level of education, 27 % of them have completed higher secondary level of education, on 18% of have completed masters.

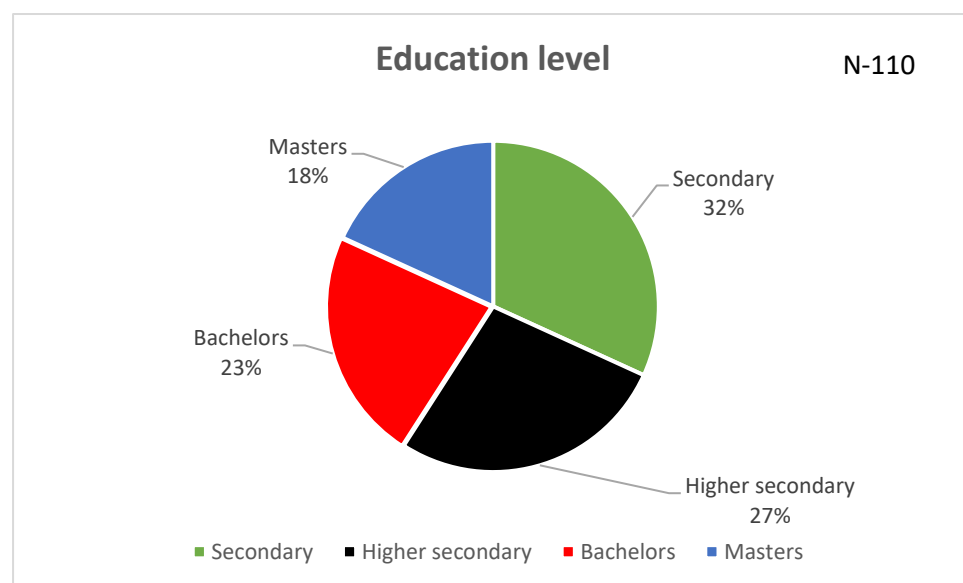


Fig. 3.1. Education level of the respondents

3.1.2 Profession of the respondents

As shown in the Fig. 3.2, out of 110 respondents, 30 of them were assistant sub engineer, 25 of them were contractor sub engineer, 20 of them were municipal sub engineer. 10 of them were contractor and sub engineer respectively, and rest 5 of them were municipal engineer

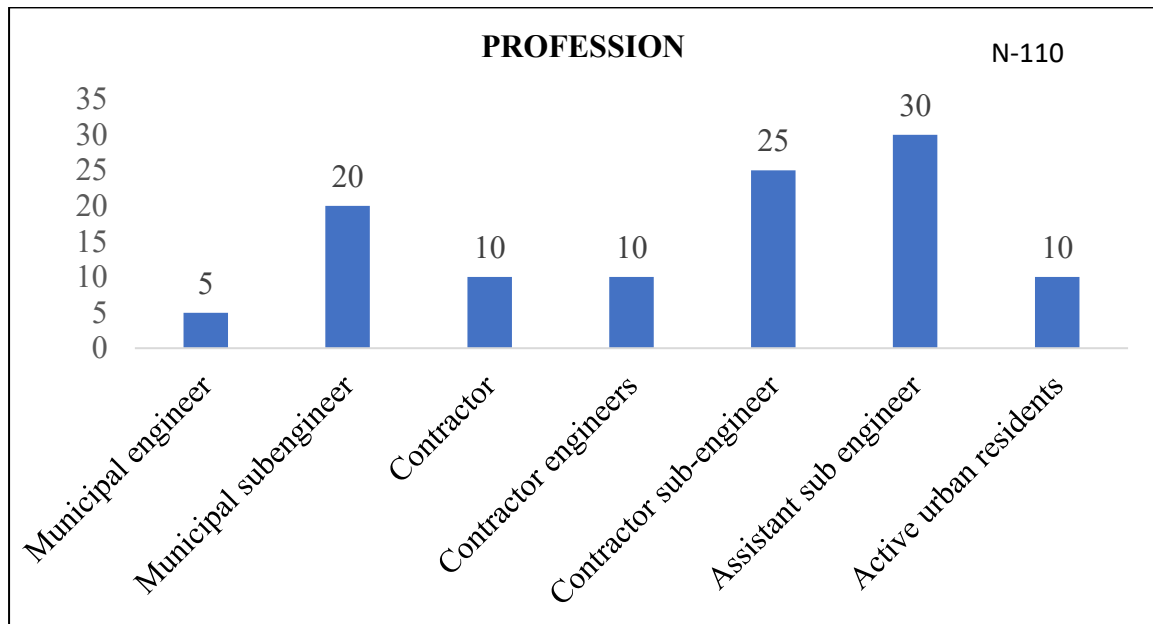


Fig. 3.2. Job of the respondents

3.1.3 Major problems with drainage in Birendranagar Municipality

As shown in the Fig. 3.3 below, one of the major problems associated with poor drainage in Birendranagar municipality of Surkhet district with the highest RII value of 0.80 is “Improper planning and old drainage system”, followed by “Irregular and untimely maintenance of existing systems”, “Poorly designed and outdated design standard”, each with the RII value of 0.78. The other problems are “Urbanization and unregulated construction”, with the RII value of 0.77. The other problems are “Limited budget for drainage development, upgrade repair and maintenance”, “Clogging issues in drainage channel”. The problems “Damages in road”, “Limited institutional capacity”, “Inadequate drainage infrastructure”, each with the same RII value of 0.75. Additionally, “Limited skilled manpower for technology and infrastructural development”, “Reactive maintenance practices than proactive”, “Environmental pollution and health hazards”, with the RII value of 0.73. The least significant problems are “Improper grading slope” and “Damages in infrastructures” with the RII values of 0.68 and 0.69 respectively.

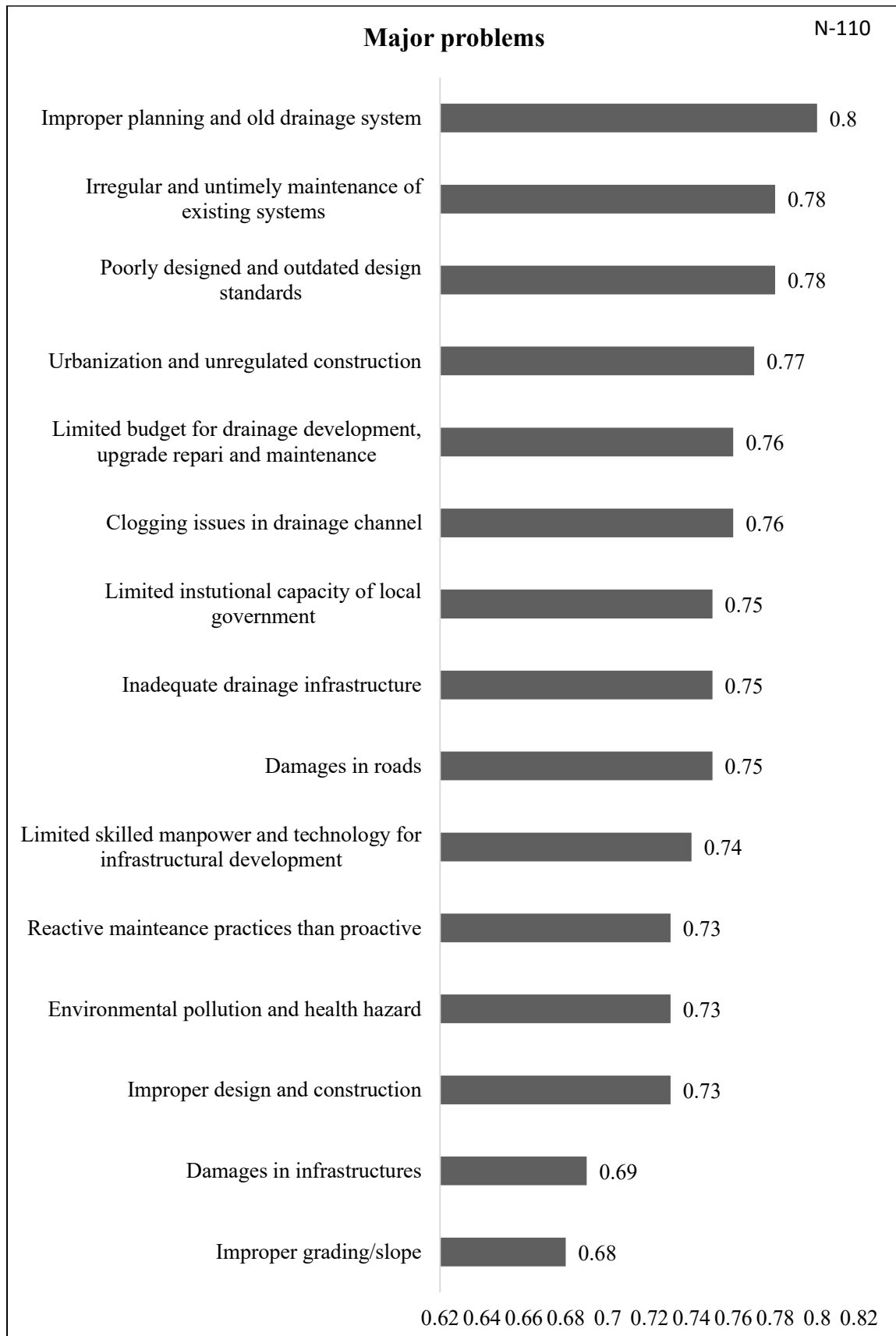


Fig. 3.3. Major problems with drainage in Birendranagar municipality

3.1.4 Causes and Effects of the Major Problem Inadequate Planning and Old Drainage System

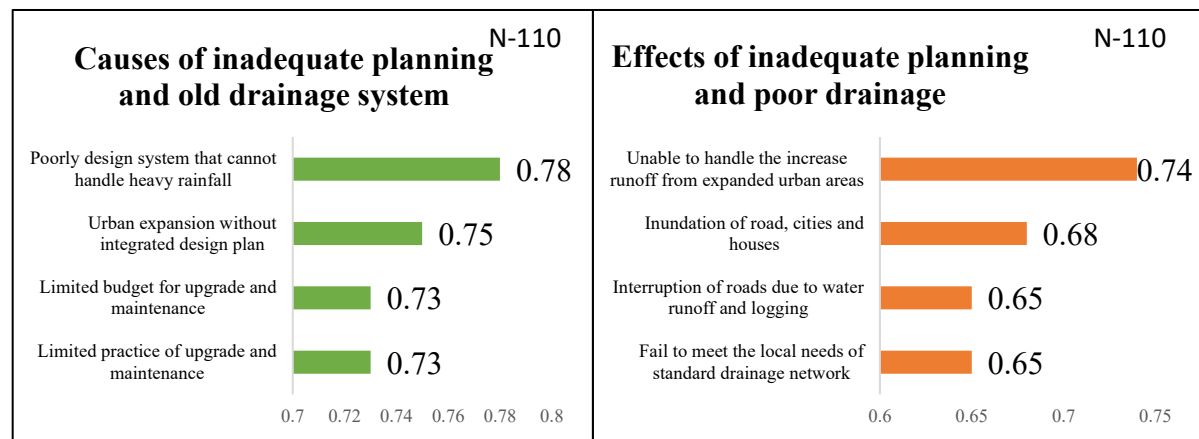


Fig. 3.4. Causes and effect of inadequate planning and old drainage system

3.1.5 Causes and Effects of Poor Designed and Outdated Design Standards

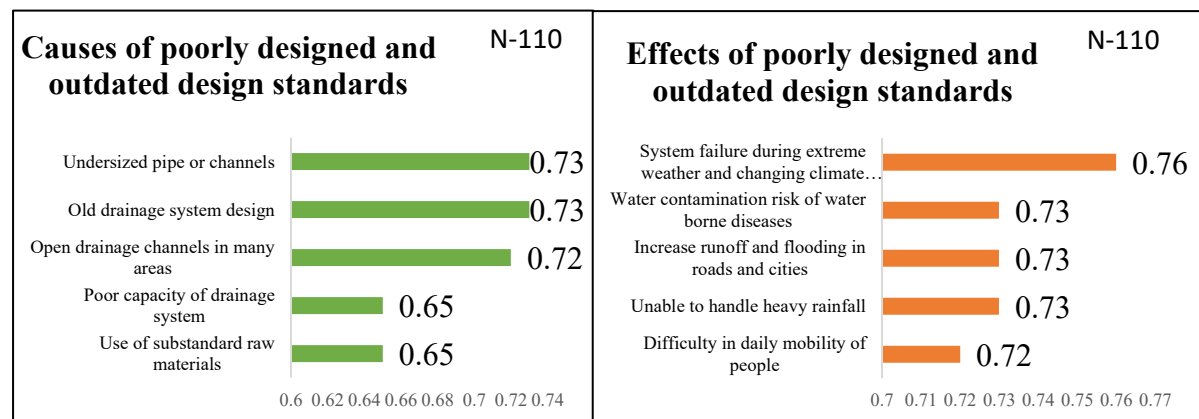


Fig. 3.5. Causes and effects of poor designed and outdated design standards

3.1.6 Causes and Effects of Improper Design and Construction

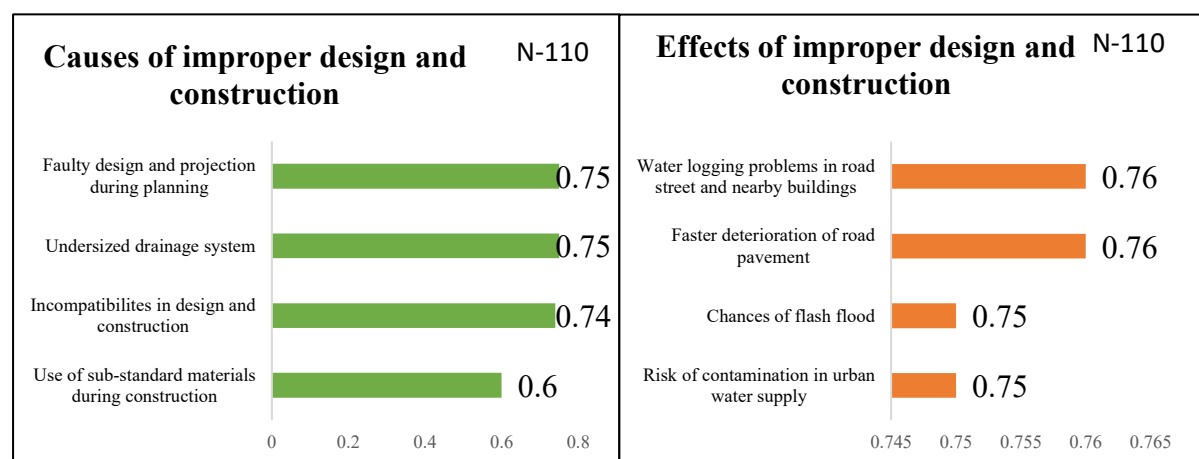


Fig. 3.6. Causes and effects of improper design and construction

3.1.7 Causes and Effects of Irregular and Untimely Maintenance of Existing Systems

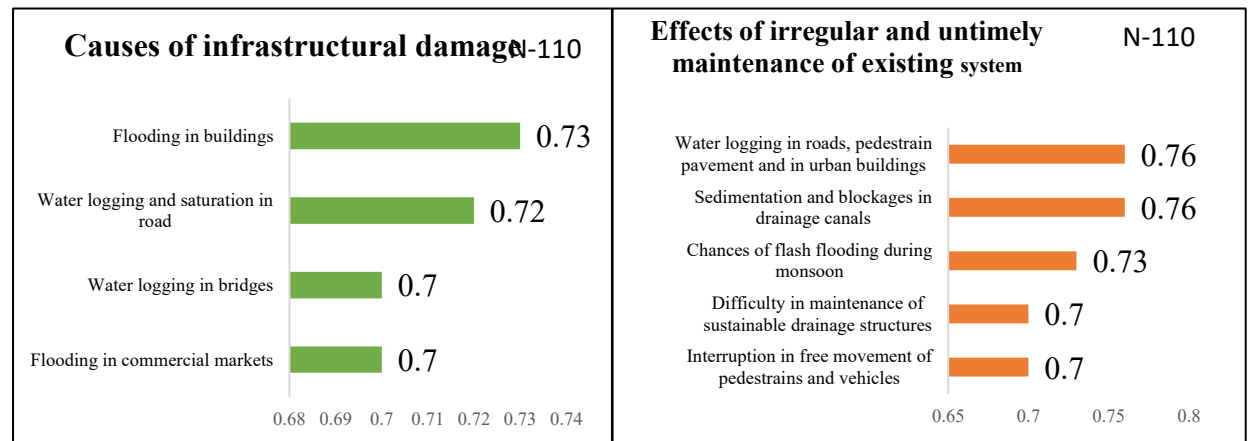


Fig. 3.7. Causes and effects of Irregular and untimely maintenance of existing systems

3.1.8 Causes and Effects of Damages in Roads

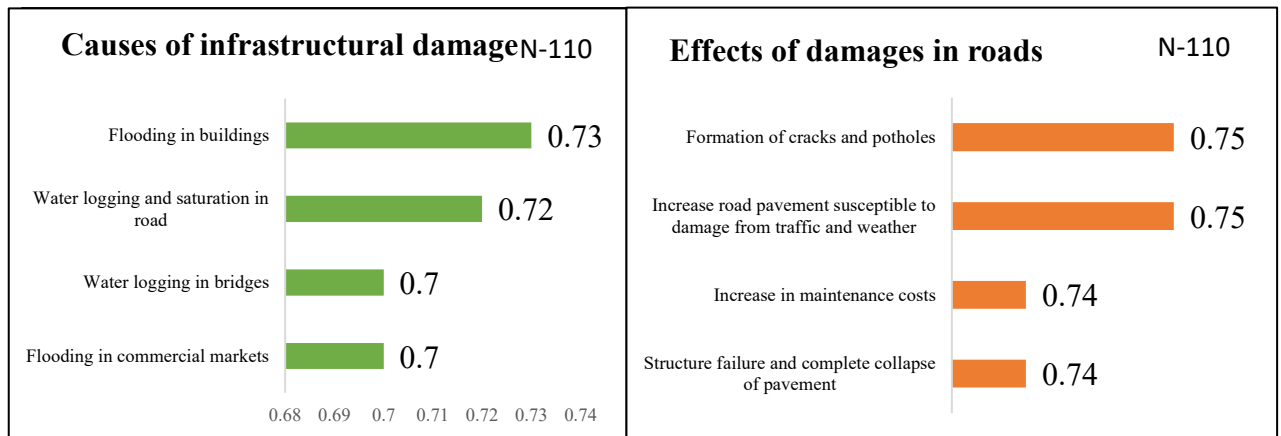


Fig. 3.8 Causes and effects of damages in roads

3.1.9 Causes and Effects of Infrastructural Damage

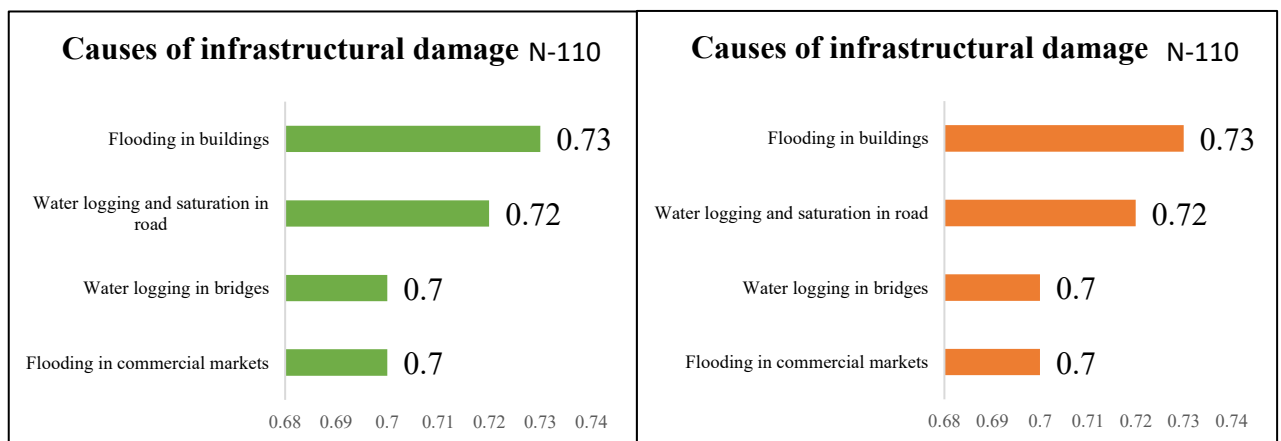


Fig. 3.9. Causes and effects of infrastructural damage

3.1.10 Causes and Effects of Environmental Pollution and Health Hazards

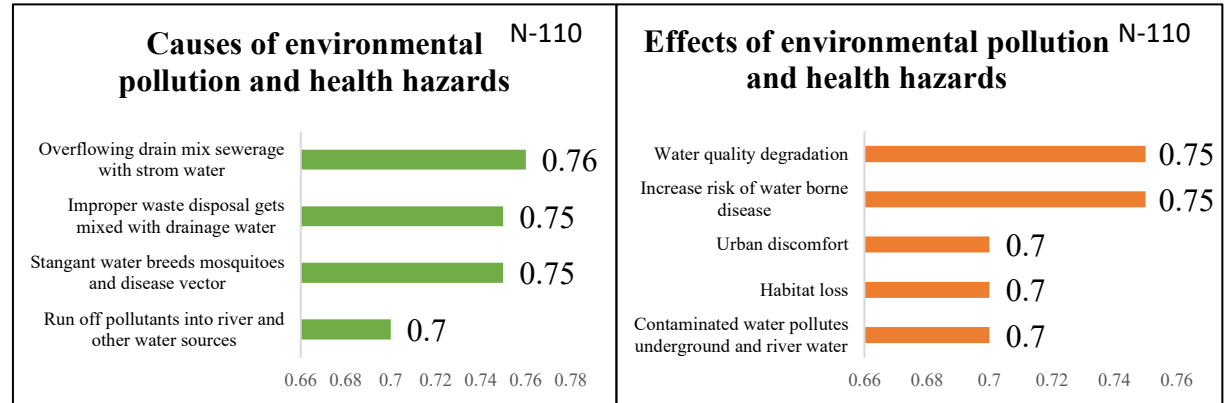


Fig. 3.10. Causes and effects of environmental pollution and health hazards

3.1.11 Causes And Effects Of Clogging Issues In Drainage Channel

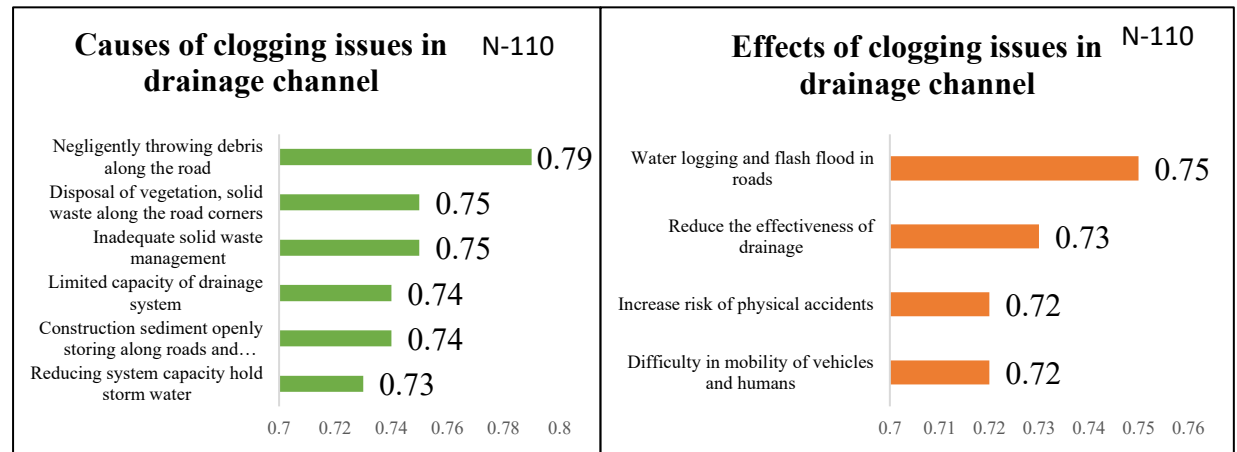


Fig. 3.11. Causes and effects of clogging issues in drainage channel

3.1.12 Causes and Effects of Inadequate Drainage Infrastructure

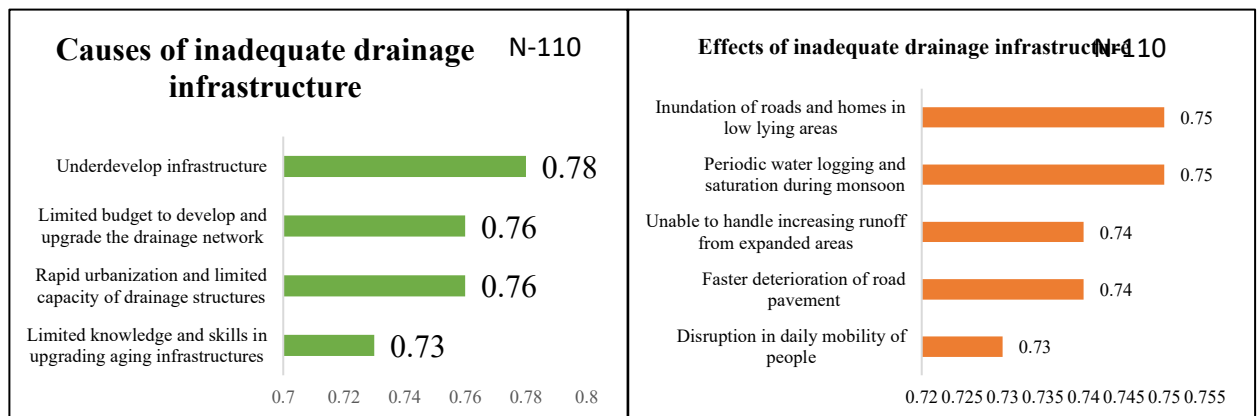


Fig. 3.12. Causes and effects of inadequate drainage infrastructure

3.1.13 Causes Of Limited Institutional Capacity Of Local Government

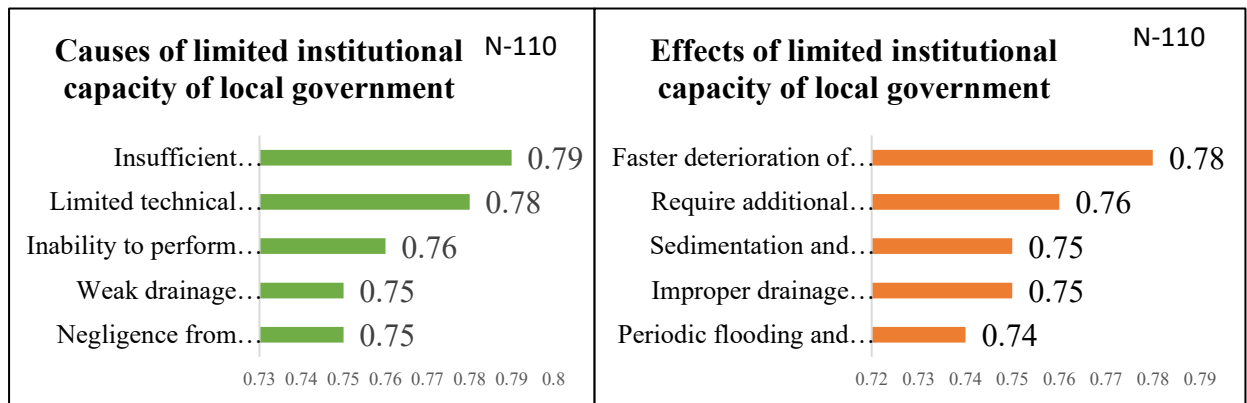
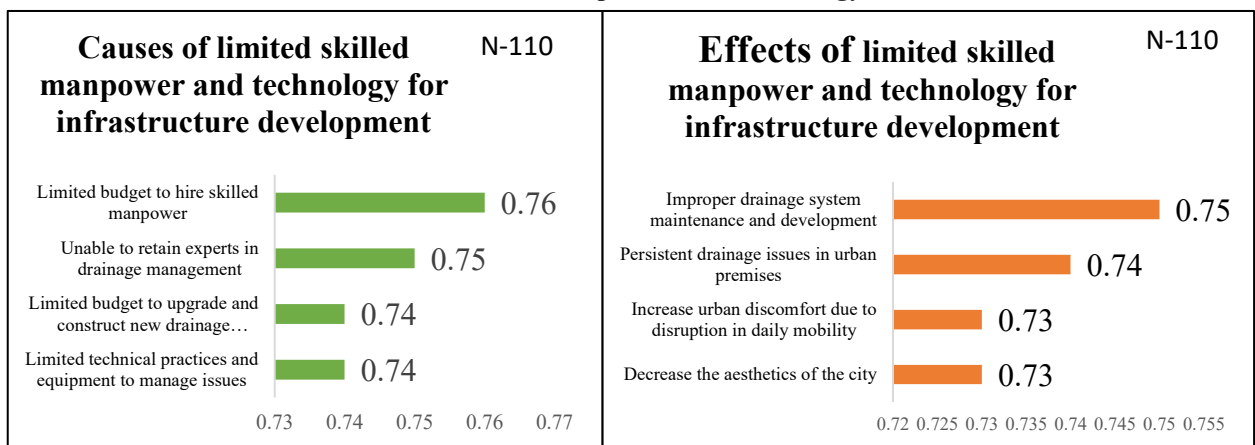


Fig. 3.13. Causes and effects of limited institutional capacity of local government

3.1.14 Causes And Effects Of Limited Skilled Manpower And Technology For Infrastructure



Development Fig. 3.14. Causes and effects of limited skilled manpower and technology for infrastructure development

3.1.15 Causes and Effects of Reactive Maintenance Practices Than Proactive

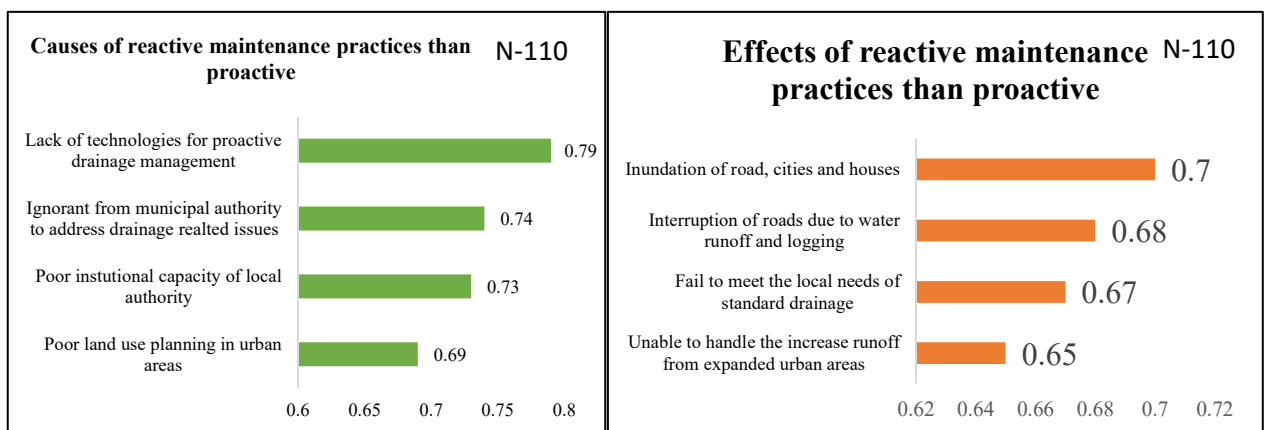


Fig. 3.15. Causes and effects of reactive maintenance practices than proactive

3.1.16 Causes and Effects Improper Grading/Slope

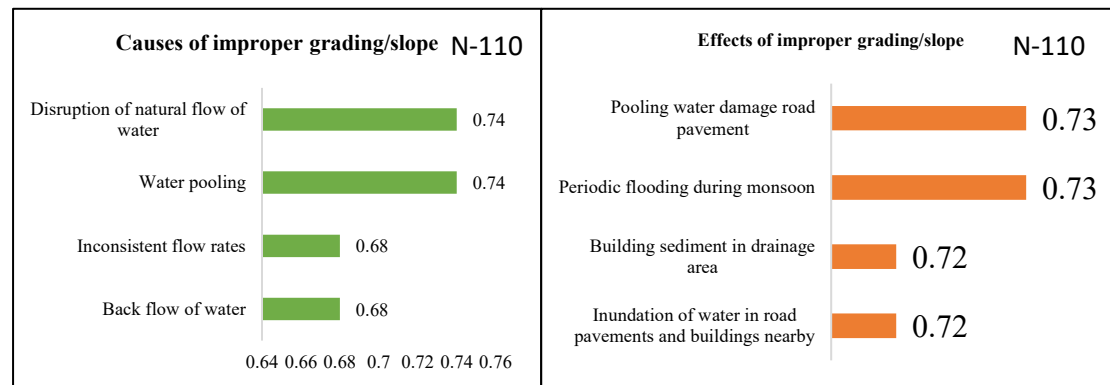


Fig. 3.16. Causes and effects improper grading/slope

3.1.17 Causes and Effects Of Limited Budget For Drainage Develop, Upgrade Repair And Maintenance

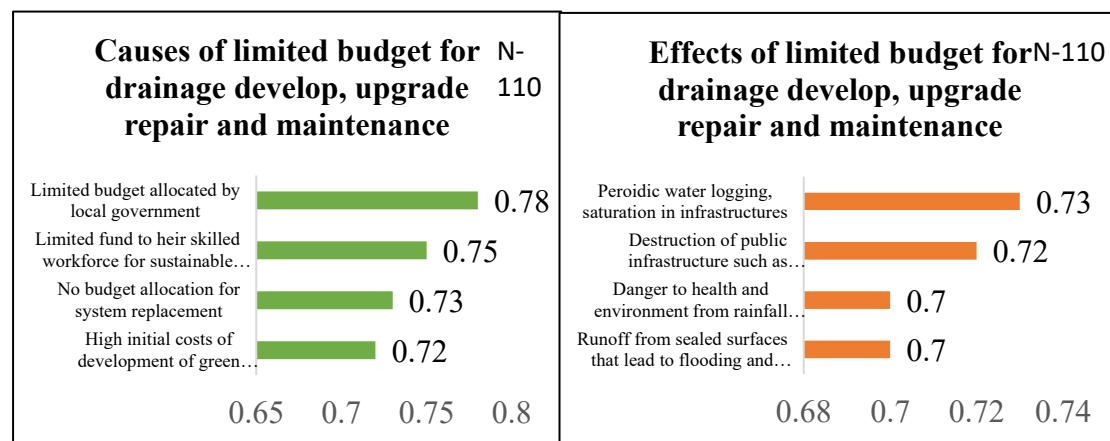


Fig. 3.17. Causes and effects of limited budget for drainage develop, upgrade repair and maintenance

3.1.18 Probable Solutions to Overcome the Problem of Poor Drainage

As shown in the Fig. 3.18 below, to overcome the ongoing problem of poor drainage and its impact on people living in Birendranagar municipality. The significant solutions put forwarded with the highest RII value of 0.79 is “Allocated enough budget and prioritize expansion and rehabilitation of drainage network”, followed by “Practice a comprehensive drainage maintenance program with the RII value of 0.78. Similarly, the other solutions drawn were “Integrate smart technologies like GIS and automated machine scheduling system, “Provide proper training and retain skilled maintenance personnel in municipalities for periodic repair and maintenance”, “Prepare planners and designers to create detailed models and optimum drainage network” each with the same RII value of 0.76. The other solutions were “Implement proper land use planning in urban areas” and “Implement nature-based solution for sustainable drainage network” both with the same RII value of 0.74. Additionally, “Investing in sustainable water management practices and efficient drainage system” and “Practice proper solid waste management system”, and “Seeking solutions for ecological and social benefits” also if practice helps in sustainable management of drainage issues.

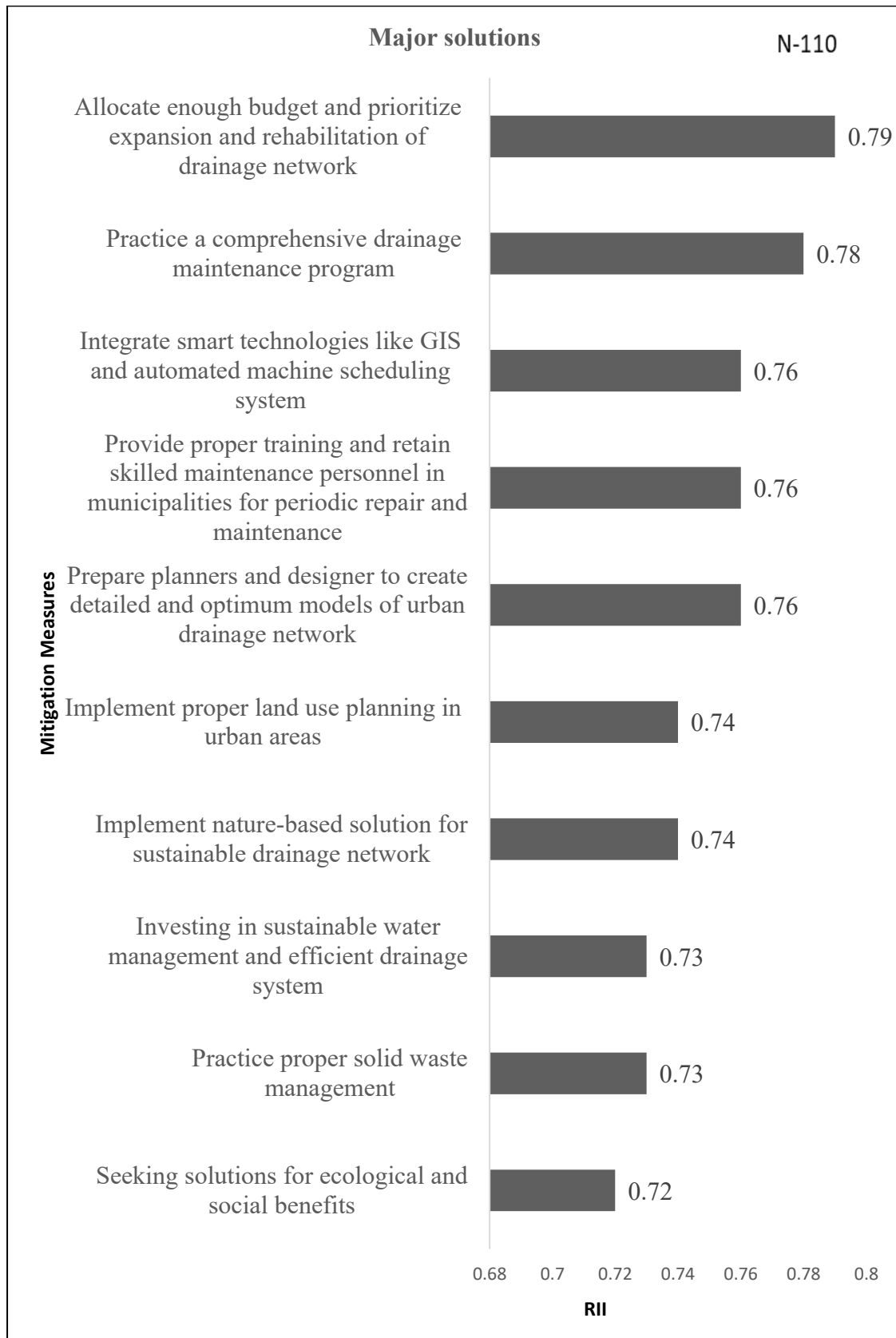


Fig. 3.18. Probable solutions to overcome the drainage issues

3.2 Discussions

i) Findings from field observation

On field observation associated with the drainage problem in Birendranagar municipality of Surkhet district, major problems seen was blocked or damaged drain, the problem with clogging and broken drainage was seen due to poor maintenance and solid waste dumping along road sides. In many areas there were no any properly designed drains, many often drainage channels were open, with run off and issues during monsoon. The poorly designed drain is unable to handle rainfall or waste water volumes, leading to frequent overflows. The lack of slope or gradient, or poor design might result in stagnant water due to flat or reserved gradient in drains. The construction of houses or shops on or too close to drainage has created obstruction in water flow. Observation during or after rains may reveal areas where roads, markets, or houses get flooded during monsoon. Residents avoid certain routes or experience difficulty commuting during rainy season.

ii) Findings from In-depth-Interview

On in-depth interview with municipal engineers, sub engineers, contractor, it is evident that the drainage issues during monsoon is a common problem in Birendra agar municipality. The flooding and water logging in the pedestrian and motorable road pavement, affect the daily mobility of people and vehicles. The major reasons behind the problems is increasing unplanned urbanization, old drainage system with inadequate capacity to handle the storm water during monsoon, often leading flash flood. The unplanned construction of houses, shops buildings along road side, blocking water pathways, haphazard deposition of construction materials, city wastages along roads side often lead to clogging of drainage routes. These has leads to faster deterioration of road pavement creating pot holes and cracks. The poor institutional capacity of local authority, to expand and update the existing drainage system is the driving issue. Apart from this, municipal ignorance the address the ongoing problem of drainage is another problem and people negligence throwing wastages along road is also driving clogging issues. Hence to overcome all these problems, it is necessary to undergo proper land use planning, stopping unplanned encroachment of land along road side, followed by regular cleaning and maintenance of drainage canal. By Prioritizing drainage issue allocating enough budget, for upgrade, expansion, regular cleaning and maintenance helps in smooth movement of vehicles as well as people, mostly during heavy rainfall.

iii) Findings form focused group discussion

On group discussion with ward president, mayor, experts, environmental officers and social active people of Birendranagar municipality of Surkhet district. The major problem they encountered is the water logging, runoff in street, and roads mostly during monsoon. Similarly, damages in drainages, leakages, with poor water storage capacity is another problem. They addressed the fact that increasing urbanization in the Birendra agar municipality, haphazard houses, shops construction, is reducing the storage capacity the capacity of drainage to manage storm water runoff. The discussion points out the fact, that negligence from municipal authority to address the issues is also driving the problem. The limited budget to upgrade and expand the drainage network is also persisting the issue. The negligence from municipal authority to periodically clean the clogging due to waste and sediment deposited along roadside is the major problem. The suggested that to overcome all these problems, the municipal authority should focus on periodic cleaning of clogging, and should come with the proper planning on land use, strict action should be taken against the encroachment of land areas, growing in city areas. The focus should be on proper disposal of municipal waste, and action against those who haphazardly throw debris along the roadside.

iv) Comparison with the past studies

Comparison with the past studies conducted on drainage related issues in urban city areas like Birendranagar, the problems of old drainage network, poor land use planning, haphazard encroachment, clogging issues, poor drainage capacity is still persistent. While comparing, on current observation few improvements has

taken place in problems related to expansion of the network, some new projects are on the phase of construction, to build new network, that was affected due to funding issues, however due to progressive delays works inception has not been seen in the field, as such the institutional weakness still persist. The persisting public behavior throwing solid waste despite, awareness program is still common in road side, because of which the clogging issue persist. The new findings showed that the rapid increment in the urban population created newer hotspots of drainage failure.

4. CONCLUSIONS

From the comprehensive analysis from tools and techniques of primary data collection. The major conclusion put forwarded for problem associated with poor drainage management in Birendranagar municipality of surkhet district are irregular and untimely maintenance of existing systems, poorly designed and outdated design standard, urbanization and unregulated construction, limited budget for drainage development, upgrade repair and maintenance, clogging issues in drainage channel. The other problems are damages in road, limited institutional capacity, limited skilled manpower for technology and infrastructural development, road damages, reactive maintenance practices than proactive. These problems are caused by poorly design system that cannot handle heavy rainfall, urban expansion without integrated design plan, untimely cleaning of wastages , limited budget for maintenance of existing system, undersized pipe or channels, old drainage system design, open drainage channels in many areas, insufficient financial resources, limited budget to hire skilled manpower, lack of proactive techniques to address drainage problems, constructing buildings in natural water paths, improper land use planning, encroachment in wetland and flood plains like pond, wells etc. The causes further drives effects such as drainage disability to handle increase run off from expanded urban areas, system failure during extreme weather and changing climate pattern, water contamination and risk of water borne diseases, increase runoff and flooding in roads and cities, sedimentation and blockages in drainage channels, chances of flash flood during monsoon, interruption in daily mobility of people and vehicles, increase road pavement susceptible to damage from traffic and weather, formation of cracks and potholes. Hence to overcome all these problems, the major solutions put forwarded were allocate enough budget: prioritize expansion and rehabilitation of drainage network by local authorities, practice a comprehensive drainage maintenance program such as regular inspections, cleaning, repair and maintenance, Integrate smart technologies like GIS and automated machine scheduling system through real time monitoring, Provide proper training and retain skilled maintenance personnel in municipalities for periodic repair and maintenance.

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