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MANAGEMENT OF SOCIAL SUSTAINABILITY AND QUALITY ASPECTS OF RURAL ROAD CONSTRUCTION IN SRI LANKA

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ABSTRACT

Though the rural roads are the final link of the transportation system, they provide the most critical connection between the city and the rural community. Further, the quality of rural roads is a significant factor to be maintained. On the other hand, maintaining quality has both positive and negative impact on social sustainability, which has been identified as one pillar of sustainability. Apart from these facts, there is a lack of research studies regarding the social sustainability and quality of rural roads at the construction stage. Although the term "social" was introduced into sustainability lately, quality is an intangible aspect. Therefore, this research was conducted to address the research gap in managing the effects of the quality of rural road construction on social sustainability. Data for the research was collected through a literature review, semi-structured interviews with conducting among fifteen selected relevant professionals of the project and an industrial document review from the documents maintained by the contractor. The research attempts to show what effects can be identified and the strategies that can be followed to overcome those effects. For that, ten social sustainability factors and fifteen quality aspects of the construction phase has taken. According to the geographical condition of the selected project area, the number of effects related to each social sustainability factor was different. Further, it was found that few quality aspects impact multiple social sustainability factors. The findings of this research prove that both accessibility and safety-related effects have been encountered critically while achieving the selected quality aspects of the rural roads during the construction stage.

Keywords: *Construction; Quality Aspects; Rural Roads; Social Sustainability Factors.*

1. INTRODUCTION

An entire country's growth and development depend on its infrastructure (Babar & Ali, 2022). Transportation is one such infrastructure that provides much more solutions to the problems encountered by the public in the country. Worldwide, around a billion people reside in rural areas without access to paved national road networks (Asher & Novosad, 2020). Transport infrastructure is a fundamental category of the transport system of any city or state (Skorobogatova & Kuzmina-Merlino, 2017). According to Stefaniec et al.,

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(2021), although the importance of social sustainability is discussed more, the current literature still underestimates its magnitude. Furthermore, to have a strong and fruitful economy, there should be a better connection between the urban and rural zones.

Rural roads are the final connection of the transport network; however, they usually give the principal connection when providing an entrance for the remote community (Donnges et al., 2007). Usually, most poor communities in developing countries live in these remote areas. Therefore, rural roads are the critical component, which addresses this gap to reduce these countries' geographical poverty (Golmohammadi, 2018). Nevertheless, on the other hand, these rural roads allow access to many rural settlements and their residents (Golmohammadi, 2018).

In order to have the maximum connectivity to habitation through the rural roads, their quality should be managed well (National Rural Roads Development, 2007). For that, significant aspects of the quality of rural roads should be identified. Since Sri Lanka is still a developing country, funding agents are willing to invest in developing infrastructure. Asian Development Bank (ADB) is a funding agent highly interested in fulfilling social requirements. Over the past few years, there has been considerable development of the rural road sector in Sri Lanka under the Integrated Road Investment Programme (iRoad), which works with the association of the ADB and supports the necessary finance (Sakamoto, 2014). Through eliminating poverty, the ADB project aimed to promote economic development and social integration by connecting people (Asian Development Bank, 2014).

Even though there have been several studies on the economic and environmental aspects of construction projects, the social side has never received as much attention (Hendiani & Bagherpour, 2019). Further, in the literature and in practice, social sustainability has received less attention than other aspects of sustainability (Rostamnezhad, 2022). Moreover, it is important to manage the negative social impacts of social sustainable projects (Treviño-Lozano, 2021). Therefore, this study is focused on discussing the effect of achieving social sustainability on the quality of rural road construction in Sri Lanka, where less attention has been given. In other words, to resolve the problem of "How to manage the effects of quality aspects of the rural road construction on social sustainability?"

This research aimed to identify the effects on the quality of rural road construction when achieving social sustainability. The aim was reached through four main objectives:

1. Identify social sustainability factors applicable to rural road construction,
2. Identify quality aspects of rural road construction applicable to social sustainability factors,
3. Investigate the effects of quality aspects on social sustainability factors in rural road construction, and
4. Investigate the strategies to overcome the effects of quality aspects on the social sustainability of rural roads.

The paper is structured as follows: The literature review is presented next and the research method adopted are presented in Section 3. Next, the results obtained by analysing the collected data are presented and discussed. Finally, the conclusions and further directions are presented.

2. LITERATURE REVIEW

2.1 ROAD QUALITY ASPECTS

Achieving acceptable performance levels from construction activities can be considered quality in the construction sector (Mishra, 2021). Since quality involves many different factors, such as changes to the physical infrastructure and the services it offers, it is difficult to determine quality in absolute terms (Mamabolo, 2016). In developing countries, high-quality infrastructure in rural villages is vital for economic development. In addition, these roads have been selected to increase input through agriculture, reduce prices, and grow local markets (Lun et al., 2013).

The Quality Aspects (QA) under the road construction stage were identified through different publications within the literature review is included in Table 1.

Table 1: Summary of literature on quality aspects in road construction stage

Quality Aspects	A1	A2	A3	A4
Design speed	X			
Distance for sight	X			
Road alignment	X			
Traffic barriers/guardrails	X			
Driveways and access points	X			
Lighting	X			
Utilities	X			
Landscaping and plant materials	X			
Bicycle accommodations	X			
Bridge and culvert replacement	X			
Roadway, right-of-way widths	X			
Pipe culvert	X			
Fixing of sign boards	X			
Procedures of controlling quality	X	X	X	
Contractor QC willingness and QC	X	X	X	X
Evaluation and availability of material		X	X	X
Material properties		X		X
Used method of construction		X	X	
Aggregate quality and crushing process		X	X	X
Gradation and crushing process, asphalt content		X	X	
Changes in mix design		X	X	
Use of marginal material		X	X	
Mixture placement and compaction operation		X	X	X
Condition of roadbed soil		X	X	

Sources: A1: The Valleys Planning Council (2008); A2: Rahangdale (2020); A3: Minde & Ghadge (2018); A4, Al- Hassan (1993)

Thirty-two (32) road quality aspects found in the literature were summarised to twenty-four (24) by considering the meanings and removing duplicates.

2.2 SOCIAL SUSTAINABILITY OF ROADS

According to Abdel-Raheem and Ramsbottom (2016), sustainability targets a connection between the given project and the system's social, environmental, and economic dimensions covered through the project. In order to provide fair access to resources, social sustainability tries to satisfy current needs without affecting the capacity of future generations to satisfy their own needs (Abdel-Raheem, 2016). Thus, this research focused on the Social Sustainability Factors (SSF) of road construction.

The SSF's were identified through different publications under the literature review. The summarised SSF from the literature is included in Table 2.

Table 2: Summary of literature on social sustainability factors in road construction stage

Quality Aspects	A1	A2	A3	A4
Accessibility	X		X	X
Availability of job opportunities	X		X	
Affordability	X			
Safety and security	X			X
Social cohesion	X	X		X
Diversity with employees and community		X		
Vitality of a community		X		
Minimising usage of non-renewable resources		X		
Changing attitudes and practices		X		
Tracking measures for social sustainability		X		
Awareness of social sustainability		X		
Global networking for social sustainability		X		
Responsibility and accountability		X		
Townscape Design			X	
Provision of social infrastructure			X	
Culture and heritage			X	
Knowledge transfer				X
Land acquisition				X
High level of vibration				X
Disposal of debris				X
Disruption of traffic				X

Sources: A1: Sakamoto (2014); A2: Abdel-Raheem (2016); A3: Chan & Lee (2016); A4: Almahmoud (2020)

Total of 23 SSF found in literature for the road construction stage were summarised to 21 by analysing the meanings and the words of the said SSF's.

2.3 RURAL ROADS

Transport is essential for producing goods and services (Véron-Okamoto & Sakamoto, 2014). Usually, rural roads are the last branch of the transportation system, but they provide an essential connection by giving entrance for the rural population to the city (Donnges et al., 2007). Rural roads connect villages and provide access to markets and services (Golmohammadi, 2018). They connect different types of social communities and give access to rural public and private property with a minimum speed in design (Bhandari et al., 2012). The connectivity enabled by rural roads has been identified as a critical solution for the community development of country areas. Rural poverty is caused by poor access to urban areas (Sankaranarayanan & Krishnakumari, 2021). Previous research has found that the type and condition of roads are linked to socioeconomic development in terms of employment, family, planning, income, and health (Sankaranarayanan & Krishnakumari., 2021). In order to overcome such issues, there is a need to develop connectivity between rural areas and urban areas.

2.3.1 The iRoads as Rural Roads

Over the past few years, the rural road sector in Sri Lanka has enormously developed under the iRoad Programme, taking ADB as the funding agent (Véron-Okamoto & Sakamoto, 2014). The iRoad programme was a proposal from the Road Development Authority (RDA) under the Ministry of Highways, Ports and Shipping (MOHPS) which was proposed in order to enhance the transportation connection with the urban and rural.

Therefore, many have proven that investing in rural roads will solve the economic and social development difficulties plaguing rural communities.

2.4 MANAGING EFFECTS OF QUALITY ASPECTS ON SOCIAL SUSTAINABILITY FACTORS

The social framework significantly impacts how people live their daily lives. The factors that make life easier, such as the physical characteristics of a home, a secure neighbourhood, the presence of schools, public transportation, parking, and green areas nearby, improve people's happiness with their homes and have an impact on their quality of life (Grum & Grum, 2020). Ensuring that the road infrastructure is planned, built, and maintained in a way that meets the requirements of the local community and improves their quality of life is one way to manage the impacts of quality factors on social sustainability in roads. A comprehensive strategy that considers the needs of the local community, the environment, and the safety of all users is needed to manage the impacts of quality aspects on social sustainability in roads. It is possible to design road infrastructure that improves everyone's quality of living by considering these factors.

3. METHODOLOGY

Data from both primary and secondary sources have been used to accomplish the four objectives of this research. Case study research strategy was used with semi-structured interviews and a project document survey as the primary sources, and the secondary data were obtained through a literature review. According to Bengtsson (2016), content analysis allows for correct inferences from verbal, visual, or written data to define and quantify certain occurrences systematically and objectively, which was the most suitable way to analyse this qualitative data. Thus, the gathered data were structured into generalised themes that shaped the research using content analysis by taking into consideration of their meanings and eliminating repetitions.

The non-probability sampling method has been used here since all the related parties cannot be interviewed due to the time constraint. Under this type of sampling, there is no known probability that every single individual in the whole community will be selected for the sample (Bhardwaj, 2019). Accordingly, this research is based on the answers given by fifteen (15) interviewees, as denoted in Table 3. The answers cannot be a simple “yes” or "no", and their points should be elaborated. Therefore, the questions that were used to collect data were predominantly open-ended.

Most importantly, document data of the project were collected. A qualitative method is studying and understanding the interpretation that groups or individuals are assigned to a social or human problem (Sukamolson, 2007). Depending on these features, a qualitative approach was preferred to fulfil the objectives of this research.

The data were collected from a one completed project from a selected period from 2015 to 2020 in the Nuwara Eliya district. This project covered the whole district under the five divisional secretariats: Walapane, Hanguranketha, Kothmale, Nuwara Eliya, and Ambagamuwa. The total number of roads they covered was forty-three (43), with 180km in the whole district, under three packages. According to the study conducted by Liyanage et al. (2021), Central Province has flat, rolling, and mountainous terrains on 200 roads which contains more road structures. Consequently, this research is limited to Nuwara

Eliya District by considering the high involvement of road structures, which is a significant aspect of the quality of roads.

Conducting 15 interviews with the relevant professionals in person were not practical with the pandemic. Therefore, interviews were conducted via the Zoom platform and by phone calls, as the secondary resource soft copies of the complaint registers of three packages maintained by the environmental officers of the contractor's organisation were reviewed. Comments from both the technical staff and community were obtained through the interviews and document review respectively.

Table 3: Composition of interviewees

Package	Contractor	Consultant	Client
01	Environmental Officer - I1 Project Manager - I4	Assistant Residential Engineer - I9 Quality Assurance Manager - I10	Social Officer - I13
02	Environmental Officer - I2 Quality Assurance Manager - I5	Environmental Specialist - I7 Social Officer - I11	Project Engineer - I14
03	Environmental Officer - I3 Technical Officer - I6	Environmental Specialist Assistant - I8 Technical Officer - I12	Environmental Officer - I15

All the 15 interviewees named from I1 to I15 as in Table 03 were selected from related professionals covering the whole three packages. Further they were from contractor, consultant and client organisations who are having the knowledge about both social sustainability and road quality.

4. RESULTS AND DISCUSSION

4.1 SOCIAL SUSTAINABILITY FACTORS APPLICABLE TO RURAL ROAD CONSTRUCTION

This section focuses on social sustainability factors (SSF) encountered in rural roads during construction. Twenty-one SSF's finalised from the literature were validated through interviews, five were identified as having a relation to rural road quality aspects, and some five new SSF's added. The first column of Table 4 shows ten social sustainability factors that are related to rural road construction. The **bolded fonts** of the Table 4 represent the newly added SSFs and QAs from the primary data collected from interviews and industry document review.

Table 4: rural road quality aspects which cause effects on social sustainability factors

Social Sustainability Factor (SSF)	Quality Aspect (QA)
1. Accessibility (SSF 1)	1.1. Roadway and right-of-way width 1.2. Traffic Barriers/ Guardrails 1.3. Utilities 1.4. Pipe culvert 1.5. Bridge and culvert replacement 1.6. Fixing of Sign Boards **1.7. Drainage facility**
2. High level of vibration (SSF 2)	2.1. Mixture placement and compaction operation
3. Disposal of Debris (SSF 3)	**3.1. Cleanliness**
4. Safety (SSF 4)	4.1. Utilities 4.2. Pipe culvert 4.3. Bridge and culvert replacement 4.4. Landscaping and plant materials

Social Sustainability Factor (SSF)	Quality Aspect (QA)
5. Culture and Heritage (SSF 5)	5.1. Roadway and right-of-way width 5.2. Utilities
6. Dust (SSF 6)	**6.1. Priming**
7. Land donation (SSF 7)	7.1. Roadway and right-of-way width 7.2. Driveways and access points **7.3. Embankment protection**
8. Disturb to agriculture property (SSF 8)	8.1. Roadway and right-of-way width **8.2. Tack Coat** 8.3. Utilities
9. Storm water entering into the lands (SSF 9)	9.1. Pipe culvert **9.2. Drainage facility**
10. Land Erosion (SSF 10)	10.1. Landscaping and plant materials

Accessibility (SSF 1) means the ease of reaching or interacting with a destination. Okamoto and Sakamoto (2014) emphasised that this (SSF) is affected due to road quality aspects. Secondary data also identified this as a social sustainability factor in rural road construction. As for SSF 2, a high level of vibration occurs in the process of obtaining the required quality through compaction. Literature surveys (Almahmoud, 2020) and industrial data identified this social sustainability factor. The third factor, 'Disposal of Debris' (SSF 3), is also identified in the literature survey (Almahmoud, 2020) the unsuitable material generated from road construction is identified as appropriately disposed of to minimise public and environmental issues.

Since the construction industry always carries some risks 'safety' (SSF 4) is a significant factor in construction (Sakamoto, 2014); Almahmoud, 2020). SSF 4 was identified from the literature and was confirmed by an industry survey. When introducing new things to the rural community, they usually get worried about their safety. They also think this threatens them, even though it fulfils their infrastructure facilities. Culture and heritage (SSF 5) also play a significant role in the sustainability of a community which is identified in both literature and industrial survey.

Furthermore, this preserves the identity of the place. Traditional and archaeologically essential structures are the tangible proofs of their culture. Therefore, preserving and respecting the heritage and characteristics of the places is essential.

Fine dust or powder of tiny particulates of earth or waste matter can be considered dust. It has numerous environmental effects and is a nuisance in the surrounding environment. Especially in road construction, dust (SSF 6) is created due to soil compaction, priming activities, and wind blowing through the unclean road surface area. This factor is also not found in the literature, thus a new factor from primary data. The next factor, 'Land donation' (SSF 7), was also a new factor not in the literature. Additional land should be acquired when there is insufficient road width to construct the road. However, the iRoad project (integrated road investment programme) did not follow the land acquisition process. Instead, the landowner has donated the required land area with a simple agreement between the landowner and the client. In most cases, this donated area was a very narrow land strip, and the landowners donated it willingly.

On the other hand, agricultural properties on either side of the construction road could be disturbed differently. For example, the vegetable beds or any cultivation could be directly damaged when those are within the ROW. Further, removing unsuitable materials could have effects on this. Thus, 'Disturb to agriculture property' (SSF 8) was a newly added SSF by industrial data review. Moreover, because of road construction activities, existing

land shapes could change, and access ways could be temporarily blocked. Then, during the rainy season, storm water enters the adjacent lands and damages structures and vegetation. Hence, 'storm water entering into the lands' (SSF 9) was also identified as a new SSF, not in the literature. Soil erosion is the removal of topsoil due to biological and physical activities. It causes loss of soil fertility and soil depredation, and finally, it impacts the sediment area. Land erosion can occur in the road construction industry due to removing topsoil and de-silted partials in an unplanned manner without following proper soil erosion practices. Consequently, Land Erosion (SSF 10) was also a newly identified SSF from the industry data.

4.2 QUALITY ASPECTS OF RURAL ROAD CONSTRUCTION APPLICABLE TO SOCIAL SUSTAINABILITY FACTORS

Twenty-four quality aspects related to road construction from the literature were validated through interviews, and ten were identified as having a relation with SSFs. While categorising the quality aspects identified from literature into what social sustainability factors are effects from these quality aspects, five new quality aspects were newly identified. The second column of Table 2 shows fifteen rural road quality aspects affecting social sustainability.

Accordingly, Roadway and right-of-way width, traffic barriers/guardrails, utilities, pipe culvert, bridge and culvert replacement, fixing of sign boards and drainage facility were identified as the quality aspects needed to consider for rural road sustainability factor of 'Accessibility' (SSF 1). 'Drainage facility' was a newly identified factor from industry data. A drainage facility is a network of artificial structures, such as storm water sewers, canals, detention structures, and retention structures, intended to gather, convey, store, divert, or discharge storm water. While the quality aspect of 'Mixture placement and compaction operation' was categorised under the High level of vibration (SSF 2), the newly identified quality aspect of 'Cleanliness' was associated with the newly identified SSF, 'Disposal of Debris'.

The four quality aspects of: utilities, pipe culvert, bridge and culvert replacement and landscaping and plant materials were already in literature and recognised as causing effects of SSF of safety. Further, the interviewees identified that 'Culture and Heritage' (SSF 5) is affected by rural road quality aspects of the roadway and right-of-way (row) width and utilities found in the literature. The entire amount of land acquired for road development is the right of way (ROW). Its width must be sufficient to handle every component of the road's cross-section, any upcoming widening of the road, and any upcoming installation of public utility facilities alongside the road. Further, utilities come under road construction referred to services and mains for water lines, pipes for storm sewers, and pipes for sanitary sewers and trenching for gas and electric lines.

Priming means adding a bituminous binder, a newly added QA from the industry data review, under the newly identified SSF of 'Dust'. While interviews newly added all the other four SSFs, few quality aspects affecting the rural road SSFs were identified. Other than to SSF 5, land erosion (SSF 7) and disturb to agriculture property (SSF 8) also affects the road quality aspect of roadway and right-of-way width, which means the entire amount of land acquired for the development of the road

Furthermore, 'Embankment protection', 'Drainage facility' and 'Tack Coat' were newly identified QAs of rural roads based on primary data. These have been identified as

affecting to the SSFs of: ‘Land donation’ (SSF 7), ‘Disturb to agriculture property’ (SSF 8), storm water entering into the lands' (SSF 9), and Land Erosion (SSF 10), receptively. Moreover, all these four social sustainability factors were newly identified from the industry survey.

4.3 EFFECTS OF QUALITY ASPECTS ON SOCIAL SUSTAINABILITY FACTORS IN RURAL ROAD CONSTRUCTION

Table 5 contains all the effects of QAs on SSFs in rural road construction identified through semi-structured interviews with 15 interviewees. These effects have been summarised through content analysis and categorised according to each SSF and QA. Table 3, presents the interviewees identification codes.

Most of the effects were encountered concerning SSF1. I1 emphasised on this by saying "Accessibility was the major factor on which we had to focus". When maintaining the given ROW, placing traffic barriers and guardrails, replacing culverts, providing drainage facilities, doing excavations for utilities, and placing sign boards, existing access points for public and private property get blocked, damaged, or have to close. I2 strongly agreed such effects on QA’s by mentioning "Accessibility related issues were encountered immensely." Further, water flew into properties when laying pipe culverts due to excavations. Due to SSF2 mixture placement and compaction operation in roads, high vibration occurs on public and existing structures. That vibration also makes cracks in existing structures. To achieve SSF 3, must deposit debris to have a clean carriage way effect on the public.

Secondly, most of the effects were encountered concerning SSF4 since safety is critical in the construction industry. I4 also mentioned “safety was the key factor we have paid our attention on” by evidencing this. It causes accidents due to the excavations done for providing utilities, accidents due to the excavations done for pipe culverts, and high-water flow rates through culverts that damage the public. Moreover, landscaping and plant materials come up with sudden landslips. When moving into SSF 5, traditional and archaeological structures usually lie within the ROW. Moreover, they have to dig near traditional and archaeologically valuable places when providing utilities.

In SSF6, when doing priming, a high generation of dust affects the public. Moreover, I6 said “Dust controlling was a critical issue we faced”. When landscaping and planting materials beside the road, land erosion can happen. When moving into SSF 8 and disturbing agricultural property, there are occasions where vegetation lies within the ROW, and when applying tack coat, it splits on tea plantations beside the road. Further, excavations for utilities had to be done through existing vegetation.

As per SSF9 when storm water enters the lands, water blocks through culverts due to less maintenance and drainage. This is also confirmed by I12 by saying “Eliminating issues on providing drainage facility need to be addressed crucially”. With SSF 10, there are effects when insufficient width for road, driveways, and access points make it difficult to access public and private property. While doing embankment protection, there is vegetation within the area.

The **bolded fonts** in Table 05 represent the newly identified SSF’s and QA’s which were not in the literature. Further, I1-I15 denotes the interviewee numbers.

Table 5: Effects on rural road quality when attaining social sustainability and strategies to overcome

Social Sustainability Factor (SSF)	Quality Aspect (QA)	Effects	Ways of Overcome
SSF 1	1. Roadway and right-of-way width	When maintaining the given ROW existing access points for public and private property get blocked or damaged **(I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15)**	• Can shift the CL of the road. • Can provide new access points. • Can provide temporary access points. • Provide new access points
	2. Traffic Barriers/ Guardrails	Access for existing property get blocked temporally or permanently and also get damaged **(I1, I2, I4, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15)**	
	3. Utilities	When doing excavations for utilities, access points for public and private property get blocked, damaged or have to close **(I1, I4, I6, I7, I8, I9, I10, I11, I12 I13, I14, I15)**	• Can provide new access points by placing cover slabs
	4. Pipe culvert	Access for houses and farms gets blocked and damaged by the excavations done and by flowing water **(I3, I4, I5, I6, I7, I8 I9, I10, I11, I12, I13, I14, I15)**	• Can adjust the place of the pipe culvert. • Can provide new places to access.
	5. Bridge and culvert replacement	Replaced culverts block existing access points and cause damages **(I4, I6, I7, I8, I11, I13, I14, I15)**	• Can shift the old access points and provide new ones
	6. Fixing of sign boards	Access gets blocked due to the placement of signboards **(I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15)**	• Can Shift the place of fixing sign board. • Change the place of access accordingly.
	7. Drainage facility	Existing accessibility of private and public property gets blocked **(I3, I4, I5, I6, I7, I8, I14)**	• Place cover slabs over drains and provide new access by providing drainage facilities according to the drawing.
SSF 2	1. Mixture placement and compaction operation	High vibration on public & existing structures and cracks due to vibration **(I1, I3, I4, I5, I6, I7, I9 I10, I11, I12, I13, I14 I15)**	• Reduce the vibrate strength of compactor and increased the number of turns. • Provide payments through insurance for damages or can use small-scale rollers.
SSF 3	**1. Cleanliness**	Effect of depositing debris in order to have clean carriageway **(I4, I6, I8)**	• Dispose them into approved locations only
SSF 4	1. Utilities	Cause accidents due to the excavations done for providing utilities **(I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, I11 I12, I13, I14, I15)**	• Spot the relevant places with safety barricades and safety sign boards. • Can provide temporary humps.
	2. Pipe culvert	Cause accidents due to the excavations done for pipe culverts **(I1, I2, I8, I14)**	• Spot the relevant places with safety barricades and safety sign boards. • Can provide temporary humps
	3. Bridge and culvert replacement	High flow rate of water through culverts and damage public **(I8, I9, I10, I11, I12, I13)**	• Provide retaining walls to avoid the damage

Social Sustainability Factor (SSF)	Quality Aspect (QA)	Effects	Ways of Overcome
	4. Landscaping and plant materials	Sudden landslips **(I3, I4, I5, I6, I8, I9, I10, I11, I12, I13)**	• Provide temporary formwork or wood shuttering near the slipping areas
SSF 5	1. Roadway and right-of-way width	Traditional and archaeological structures lie within ROW **(I1, I2, I3, I4, I5, I6, I9, I10, I11, I12, I13, I14, I15)**	• Shift the road CL on that place
	2. Utilities	Had to dig near a traditional and archaeologically valued place **(I2, I9, I15)**	• Can shift the place of excavation and put a bypass in pipeline
SSF 6	**1. Priming**	High generation of dust and its effects on public (**I1)**	• Use manual techniques instead machines • Watering the road surface within selected • time intervals
SSF 7	1. Roadway and right of way width	Not enough width for road **(I1, I4, I6, I7, I14)**	• Land was donated to the RDA by discussing
	2. Driveways and access points	Difficulty in accessing in to public and private property **(I7)**	• Apply cover slabs and provide the access point
	3. Embankment protection	Vegetation within the area **(I7)**	• Negotiation and get donated the land
SSF 8	1. Roadway and right-of-way width	Vegetation within the ROW **(I15)**	• Wait until harvesting
	2. Tack Coat	Splitting of tack coat on tea plantations beside the road **(I2, I3, I4, I5, I6)**	• Make temporary coverings by tarpaulin
	3. Utilities	Excavations for utilities through vegetation **(I4, I6)**	• Wait until harvesting
SSF 9	1. Pipe culvert	Water block through culverts due to less maintenance **(I11, I13)**	• Clean the blocked culverts
	2**. Drainage facility**	Drainages get blocked **(I11, I13)**	• Clean the drainage paths
SSF 10	1. Landscaping and plant materials	Land erosion can happen **(I1, I11, I13, I15**)	• Turfing can be done and packing sand • Provide small boulder packing as a temporary solution

4.4 STRATEGIES TO OVERCOME THE EFFECTS OF QUALITY ASPECTS ON SOCIAL SUSTAINABILITY OF RURAL ROADS

Similar to the effects, ways to overcome those effects also have been identified through the interviews. In the last column of Table 3 strategies to overcome the effects of quality aspects on the social sustainability of rural roads are shown. These strategies have been summarised through content analysis and categorised according to each SSF and QA. According to the interviewees, they have followed these strategies within the iRoad project and what they propose with the vast industrial knowledge they gained.

As strategies to overcome the effects related to SSF 1, most interviewees came up with the solution of replacing the existing access point and providing new access points or temporary access points by using cover slabs. To reduce the damage due to high vibration

(SSF 2), they gave solutions such as reducing vibrate strength, increasing turns and providing insurance for damages.

To reduce the effects of disposing of debris (SSF 3), they have introduced approved locations place; dump yards to dispose of them without disturbing the public. To overcome the effects related to SSF 4, they have come up with solutions like spotting the relevant places with safety barricades and sign boards, providing retaining walls, and providing temporary formwork or wood shuttering near slipping areas. Effects related to SSF 5 can be overcome by shifting the road CL on that place and can shift the place of excavation and putting a bypass in the pipeline. For the effects related to priming, manual techniques were used to water the road surface within a selected time interval.

As strategies to overcome effects related to SSF 7, they have used turfing to provide sand and boulder packing as temporary solutions. To overcome the effects of disturb agricultural property, making temporary coverings by tarpaulin and waiting until harvesting was followed. For the effects of 'storm water entering into the lands', the blocked culverts and the drainage paths can be cleaned.

Land was donated to the RDA by discussing applied cover slabs and providing the access point, get discussed and get donated the land was the strategies to overcome the effects related to SSF 10.

5. CONCLUSIONS AND FUTURE DIRECTIONS

QAs of rural road construction were identified through a literature review, semi-structured interviews, and an industrial document review. The research newly identified SSF's related to rural road construction, such as debris disposal, dust, land donation, disturbance to agricultural property, storm water entering the lands, and erosion. Under the investigation of effects on the quality of rural road construction to social sustainability factors, five new SSFs and five new QAs of rural roads during the construction phase were identified. Among these QA's, a few cause effects on more than one SSF. Then the effects related to each QA and ways to overcome them were also identified. Nevertheless, the effects identified and how they are overcome regarding each quality aspect vary from one SSF to another. As the recommendation among the effects, most were related to accessibility and right-of-way (ROW) widths. To overcome this effect, it is better if the relevant government authorities, like the Road Development Authority or the Local Authority, can mark the ROW of the road. Marking the ROW will reduce the impact on the public and the road's quality while construction is underway.

This research introduces new social sustainability factors and new quality aspects related to road construction. For those willing to do their research related to these key topics, they can take them as literature. Further effects and the strategies to overcome them can also be used in future researches. On the other hand, the RDA, designers, consultants from the road projects, contractors, project managers, and social officers can use this as a guide for future problems. Due to the limited time frame, only qualitative data was collected. However, one can extend this research to a quantitative approach by measuring and giving value to each tangible quality aspect. Apart from these limitations, conducting interviews via an online platform and the safety measures taken to protect each respondent's identity also acted as limitations for this study. However, the research findings can be used to manage the effects of QAs on SSFs in rural road construction projects in Sri Lanka.

As the future direction, one can evaluate this for the whole country since this research only collects data from one construction organisation (contractor, consultant, and client) and is limited to the Nuwara Eliya district. Therefore, in addition to the quality aspects and social sustainability factors summarised in this research, various new quality aspects and social sustainability factors may be identified by expanding this research to the whole country.

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