

## Assessment of Irrigation System Performance with Socio-economic indicators: A GIS-based study in the Medagama Block of Mahaweli System C

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**ABSTRACT.** *The performance assessment is a strategy to diagnose the deficiencies in existing irrigation systems and to take appropriate management options to correct those. Socio-economic evaluation is a part of this assessment to get a better understanding of the performance of the farming society within the irrigation system. This study was carried out to analyze the performance within Mahaweli System C by means of spatially varying socio-economic indicators considering the Medagama management block as the study area. The education attainment, quality of housing, access to household consumer durables, access to vehicles in households, and income level of household were the selected indicators to study the socio-economic variability within the study area. A hamlet was taken as the smallest spatial unit to collect data and for mapping purposes. The overall performance index was obtained by summing up the set of indicators by providing relative weights. All the indices were mapped to show the spatial distribution and variability. According to the derived results, the origin of the settlers, the literacy level of the children, their motivation to achieve a better living condition are the factors, which influence on the variability of the socio-economic performance. A medium socio-economic performance was observed in all hamlets except in Henanigala South, where the Adiwasi people are settled. It seems that they have not well adjusted to the system even after three decades of settling. The stakeholder analysis identified the Mahaweli Authority of Sri Lanka and farmer organizations as key stakeholders who can influence on the success of the system performance. A socio-economic evaluation is important to get a feedback of the system performance. Irrigation system performance is highly influenced by other factors such as rainfall and climate conditions, cropping patterns and crop water requirement, soil type, management factors, marketing and other monetary factors. Therefore, an overall irrigation system evaluation is needed with an overall assessment, considering the technical and socio-economic indicators. Thus, this system should be further evaluated by using indices of water delivery performance, financial, productivity and environmental performances. It is important to assess the spatial variability as well as the temporal variability of the performance to identify the improvements of the system performance with time.*

**Keywords:** *Assessment, Mahaweli System C, socio-economic performance*

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## INTRODUCTION

With the increasing population, securing of food and water has become a greater challenge in most of the countries in the world. Therefore, introduction of irrigation into dry areas and increasing productivity by innovations have been attempted. Since, 75% of fresh water in worldwide has being consumed by irrigated agriculture, more efficient, effective and sustainable use would be more important and it would help to cope with water scarcity in other sectors (Selin, *et al.*, 2008). Irrigation is critical to food security and economic growth in a country. The wide gap between actual and desirable performance threatens the sustainability of irrigated agriculture. The challenges for increasing the productivity of irrigation systems have forced countries to think of new strategies. Thus, diagnosis of existing irrigation services and modernization options are needed. This type of diagnosis process can be achieved through performance assessment (ICID, 2010).

Performance assessment of irrigation and drainage is the systematic observation, documentation and interpretation of the management of an irrigation and drainage system, with the objective of ensuring that the input of resources, operational schedules, intended outputs and required actions proceed as planned (Bos *et al.*, 2005). The ultimate purpose of performance assessment is to achieve an efficient and effective project performance by providing relevant feedback to the project management at all levels in the irrigation system (Selin *et al.*, 2008).

The *Mahaweli* System “C” area is located on the right bank of the *Mahaweli* river and covers an extent of 68,614 ha. The irrigation system in *Mahaweli* system C was first operated in 1983 with irrigation water delivery to the area and fully completed in 1994 (Gunawardena, 2001). Although the System C had made a significant contribution towards the rice production and employment generation in the country, still it is considered that several aspects of project components have to be attended for the sustainable management of the System (Siriwardena, 2002). To fulfill the efficiency and the sustainability of the System C, it is important to get the feedback through socio-economic performance, because it can be considered as the indicator of economic growth, social upliftment and the productivity improvement (Siriwardena, 2002). Therefore, it is needed to assess the performance variation over the system with the specific indicators and attend to issues which cause performance variability. This will help to make necessary changes to achieve high efficiency and sustainability in the future.

### Objectives

The main objectives of this study were to assess and map the socio-economic performance of the *Medagama* Management Block of *Mahaweli* System C considering hamlet as the basic spatial unit and to evaluate the stakeholder involvement in the system performance.

### Study area

Mahaweli System C consists of seven management blocks namely *Medagama*, *Sandunpura*, *Siripura*, *Nuwaragala*, *Mahawanawela*, *Veheragala* and *Girandurukotte*. The *Medagama* management block was selected for the study since a considerable diversity was observed in terms of its settlers during the initial field visits. It consists of settlers from various locations including people from *Dambana* (*Adivasi* people). Settlements of people and the development were started in 1982. The *Medagama* block is located in Zone 3 of system C

and comes under the administrative district of *Ampara* and the *Dehiatthakandiya* Divisional Secretariat division. *Medagama* covers an extent of 5003 ha. According to the management aspects of the Mahaweli Authority of Sri Lanka, *Medagama* area is divided in to three main management units called *Nawamedagama*, *Diyawiddagama* and *Henanigala* and these units are further subdivided into 11 hamlets. Table 1 illustrates the categorization of these hamlets under each unit.

**Table 1. The basic three units of the *Medagama* Block and the categorization of hamlets**

Unit Name	<i>Nawamedagama</i>	<i>Diyawiddagama</i>	<i>Henanigala</i>
<b>Hamlets</b>	1. <i>Medagama</i>	1. <i>Wawgama</i>	1. <i>Henanigala North</i>
	2. <i>Ihalagama</i>	2. <i>Wawmadagama</i>	2. <i>Henanigala South</i>
	3. <i>Pahalagama</i>	3. <i>Diyawiddagama</i>	3. <i>Kalegama</i>
	4. <i>Kudagama</i>		4. <i>Paranagama</i>

The total land extent was divided as homestead at highland areas and paddy lands at lowlands. Accordingly, 3146 number of homesteads was settled and 2302 number of paddy lands was set for cultivation. The lowland area provided to the farmers is 1 ha and provisions are not provided to subdivide this land into smaller parcels.

## METHODOLOGY

### Materials, data and data sources

Primary data on socio-economic conditions were collected through a questionnaire survey during 2005/06 *Maha* season. Secondary data on land use and administrative boundaries were collected from the GIS unit of MASL.

The hamlet was considered as the smallest spatial unit and a sample comprised of 20 randomly selected farmer families selected from each hamlet for the socio-economic survey. Accordingly, a total of 220 farmer families were surveyed. The following socio-economic indicators were selected to assess the performance of farmer families.

1. Education attainment of children (EDU)
2. Quality of housing (QH)
3. Access to household consumer durables (AH)
4. Farm income level of household head (FI)
5. Non-farm income level of household head (NFI)

Each socio-economic indicator was ranked in to three levels called high (3), medium (2) and low (1). According to the collected information, each family was ranked high, medium or low. Finally, the performance indicator for each hamlet was calculated by obtaining weighted average of the performance of each household in the sample.

### Calculation of the overall performance index

The overall performance index value for each hamlet was calculated by using the set of indicators. The indices that were selected to find out socio-economic performance variability were seemed to be influenced by the system performance in two different ways as causes and impacts. Some indicators were identified as causes for system performance while others were identified as the impacts of system performance. As this study was based on the spatial variability of the system performance after its implementation, only the impact related indicators were identified for the analysis of the performance. As a result, education attainment of household head was removed in the overall performance assessment. In addition, all the selected performance indicators do not contribute equally to the system performance. Hence, it was important to identify the relative importance of these indices and expert opinion was sought in this respect. The relative weights identified by the expert groups are given in Table 2. These persons comprised of higher officials of MASL, representative members of farmer organizations and other beneficiaries of the system.

**Table 2. Relative weights suggested by the experts for each performance indicator**

Index	Relative weight
Education attainment of children(EDU)	0.15
Quality of housing (QH)	0.25
Access to household consumer durables (AH)	0.15
Farm income level of household head (FI)	0.35
Non-farm income level of household head (NFI)	0.1

The overall performance index of the hamlets was calculated as follows.

$$\text{Overall performance} = ((\text{EDU} \times 0.15) + (\text{QH} \times 0.25) + (\text{AH} \times 0.15) + (\text{FI} \times 0.35) + (\text{NFI} \times 0.10))$$

### Assessment of the stakeholder involvement

A Stakeholder analysis was carried out to identify main stakeholders within the project and how they contribute on the system performance. All the stakeholders which have been affected by the project activities were identified and listed. All the listed stakeholders were categorized according to criteria relevant for the project based on their activities, interests, affects and beneficiaries. Then they were grouped in three groups; key stakeholders, primary stakeholders and secondary stakeholders. More detailed analysis of selected stakeholders was done by using a detailed and organized table of describing their characteristics, relations, interest and the power.

According to the table of stakeholders that was previously described the importance and the influence of each and every stakeholder were identified and presented as a table of matrix (<http://stakeholdermap.com/stakeholder-analysis.html>). The level of importance and the level of influence were graphed along the x-axis and the y-axis. In the graph, the influence increases along the x-axis. Thus, more influence stakeholders are coming while going towards the right on the x-axis. The y-axis is the importance, thus more important stakeholders are coming while moving up along the y-axis. Table 3 describes the influence

and importance matrix and how the stakeholders have been grouped according to the level of importance and the level of influence that they have.

**Table 3. The method how the stakeholders are grouped based on influence and importance**

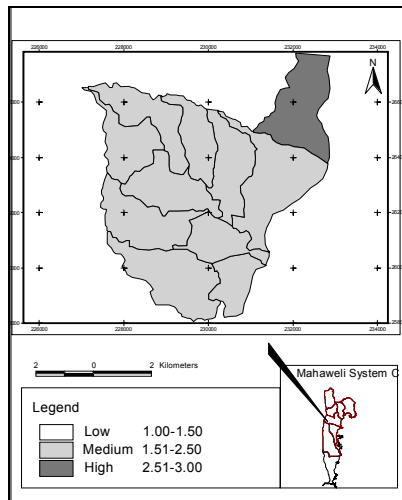
Level of Importance ↑	<b>High importance/Low influence</b>	<b>High importance/High influence</b>
	Stakeholders of high importance to the activity. But low influence	Stakeholders of high importance to the activity who can significantly influence to success.
	<b>Low importance/Low influence</b>	<b>Low importance/High influence</b>
	Stakeholders who are of priority but may need limited monitoring. They are unlikely to be the focus of the activity.	Stakeholders with high influence, who can affect outcome of the activity, but whose interest are not the target of the activity.
	Level of influence →	

### RESULTS AND DISCUSSION

The following sections describe and present the results obtained during this study.

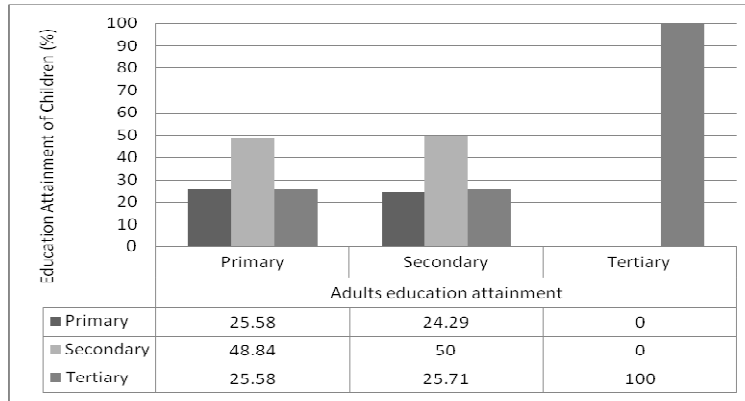
#### 1. Education attainment

Education attainment of the children is presented in Fig. 1.



**Fig. 1. Education attainment of children**

*Henanigala* North has achieved the high level of education attainment of settlers' children. Since settlers of this area are originated from the places like *Theldeniya* in Kandy, adults also have a good educational background. The relationship between the education level of household head and their children's education attainment is presented in the Fig. 2.

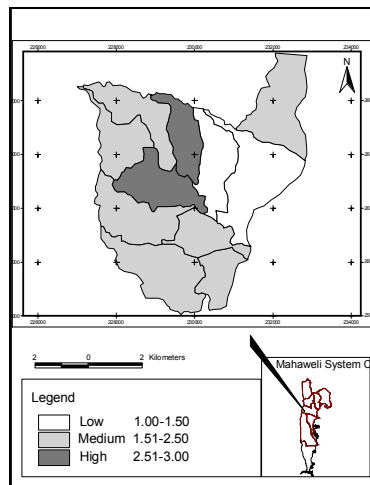


**Fig. 2. Relationship between education attainment of the household head and children**

According to Fig. 2, higher percentage of children of who's parents with tertiary level education has educated upto tertiary level. It implies that children of educated parents have higher chances of going for higher education compared to the children of others two categories. Relatively high percentage of children of the mothers with tertiary level education has gone up to tertiary level education.

## 2. Level of housing condition

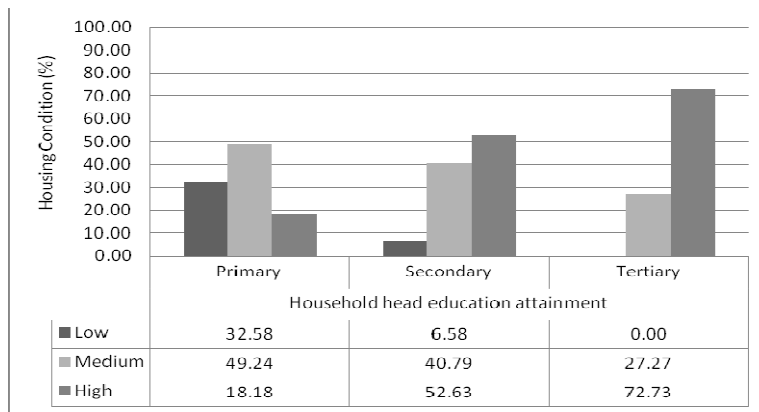
Fig. 3. represents the spatial distribution of quality of housing within the *Medagama* block.



**Fig. 3. Quality of housing**

As shown in the Fig. 3. two hamlets, *Medagama* and *Kudagama* are coming under the high level in quality of housing and the highest value of 2.65 was observed from Kudagama. It is identified as a small built-up township area which is occupied by good infrastructure facilities with easy accessibility. Majority of people living in this area are employed in government institutions. Thus up-liftment of livelihood would be a reason for quality housing. It is evident that behavioral and cultural values of the people like to have a significant impact on their living conditions. Thus, as similar to the results illustrated in the previous index of education attainment, origin of the people seems to be a considerable factor related to housing condition of them. Accordingly, it is evident that poor housing condition is associated with the settlers from *Dambana* and *Ampara* areas. Settlers from *Kothmale* have better housing conditions with medium and high levels.

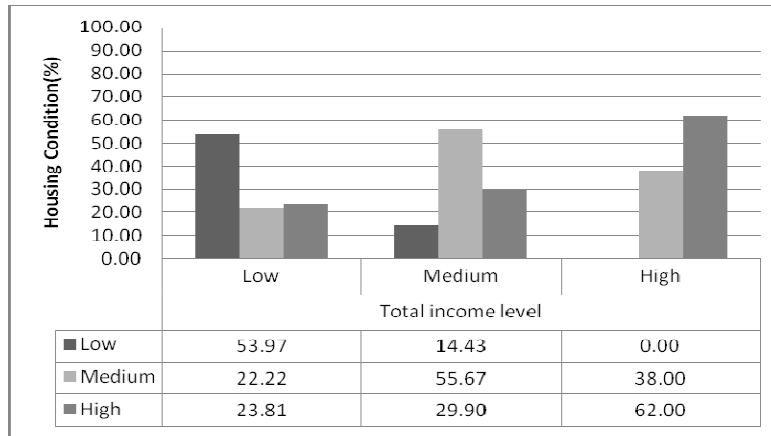
The relationship between the education level of household head and housing condition is presented in the Fig. 4.



**Fig. 4. Relationship between education attainment of the household head and their housing condition**

According to Fig. 4. higher percentage of higher level housing condition was observed with household heads with tertiary level education. Thus, it is proved that people are seemed to be motivated to gain better living conditions when they are with good education.

The relationship between the total household income and housing condition is presented in the Fig. 5.



**Fig. 5. Relationship between the total household income and their housing condition.**

Poor housing condition is associated with the low income levels as shown in Fig. 5. Medium and high level of housing conditions are associated with relatively high income levels. It is evident that people tend to get their living conditions improved with the increasing income. In addition, according to the results it is evident that poor housing conditions are associated with the settlers from *Dambana* and *Ampara* areas. Settlers from *Kothmale* have better housing conditions (medium and high).

**3. Access to household consumer durables**

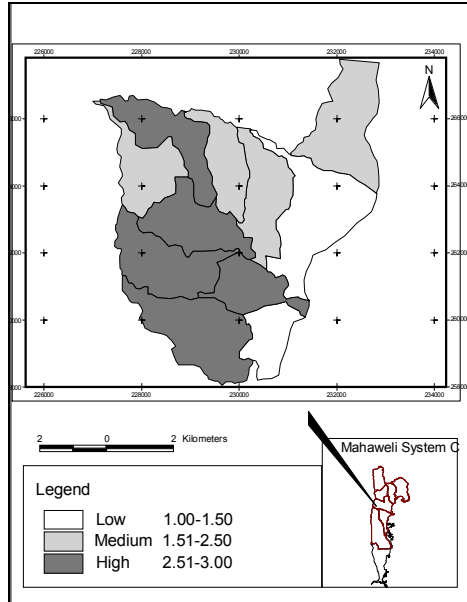
Since *Kudagama* is more likely to be a small township area, it shows the highest value in owning household items. In addition, the people living in the area are mainly the government servants hence, better livelihood and their motivation to achieve a better living condition seemed to be good reasons to achieve more consumer durables in houses.

According to the analysis, there was a clear increase in high access to household consumer durables with increasing income. Group with relatively high income have medium and high access since they are financially affordable to purchase the goods.

**4. Farm income level of households**

Fig. 6. presents the farm income level of households in each hamlet.





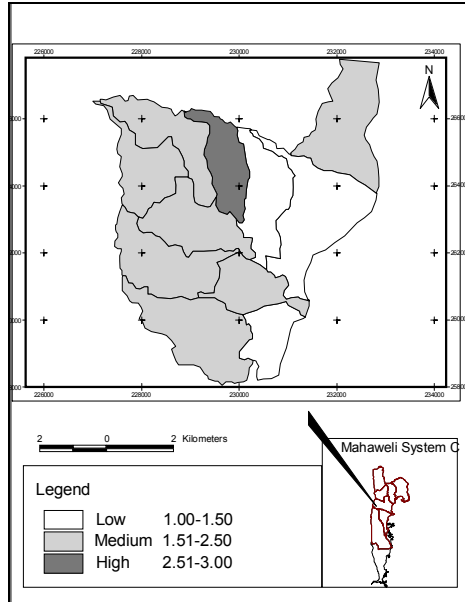
**Fig. 6. Farm income level of households**

The highest value might have resulted due to availability of ample amount of water sources by two tanks in *Wewmedagama*. Water availability is an essential factor in agriculture. In addition to that *Medagama*, *Wewgama*, *Kalegama*, *Henanigala North* and *Pahalagama* are the other areas which show better performance in farming.

Considering the employment category of the household heads recorded from *Henanigala South*, minority (25%) of them were involved in farming. The least agricultural performance and poor motivation were recorded from *Henanigala South* and it has further emphasized by the study conducted by IWMI in *Mahaweli system C* upgrading project in 2004 (IWMI and JBIC, 2004). It has recorded only 81% low cropping intensity and paddy yield of 3.85 and 3.56t/ha during two seasons; *Yala* and *Maha* respectively and those values were remarkably deviated from the average cropping intensity of 151% and average yield of 4.14 and 4.19t/ha for two separate seasons in System C.

##### 5. Total income level of household

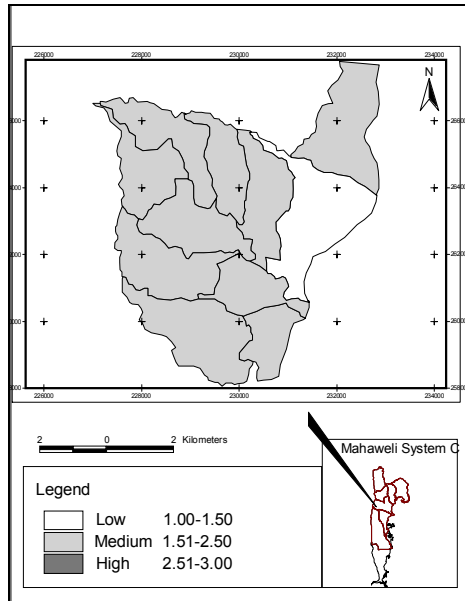
Fig. 7. presents the spatial variability of total income level of households. Consequently, high values were observed from *Kudagama* in both non-farm and total income level of households. Hence, it has proved that non-farm income has highly contributed to the total income of the households. Considering the employment category of the household head it has recorded that a considerable portion (35%) of people in this area have involved in non-agricultural activities.



**Fig. 7. Total income level of household**

### 6. Overall variability of the socio-economic performance

Fig. 8. presents the spatial variability of the overall socio-economic performance within Medagama block.



**Fig. 8. Overall performance level of hamlets**

In overall, medium level performance in socio-economic aspects can be seen in all hamlets except in *Henanigala* South. The low performance in individual indicators has resulted in low overall performance in this hamlet. It is evident that the *Adiwasi* people who are settled in this hamlet have not gained a significant improvement in their socio-economic condition with respect to the other settlers. The change of livelihood to farming has not gained a significant improvement in this society hence it is important to identify suitable measures to improve their livelihoods through attitude changes since they are living in a farming environment at present.

**7. Stakeholder Influence on System Performance**

Table 4 presents the level of influence and importance of different stakeholders in the system.

1. Farmers/settlers
2. MASL ( Mahaweli Authority of Sri Lanka )
3. Farmer organizations (FO)
4. Lanka fertilizer co-operation
5. Farm input suppliers
6. Bankers
7. Farm output buyers
8. Farm credit suppliers
9. Agriculture department
10. Insurance institutions
11. Irrigation department
12. NAQDA (National Aquaculture Development Authority)
13. NWSDB (National Water Supply and Drainage Board)
14. NGOs (Non Government Organizations)
15. CBO (Community Based Organizations)

**Table 4. Level of influence and importance of different stakeholders**

<b>A</b>	<b>High importance / Low influence</b>		<b>B</b>	<b>High importance/ High influence</b>	
	7	1	3		2
6	5				
8		9			
	4				
<b>C</b>	<b>Low importance/ Low influence</b>		<b>D</b>	<b>Low importance/ High influence</b>	
		14		13	
15				11	
		10		12	

MASL and FO are the two key stake holders who has significantly influenced on the project activities and important to the success of its performance. MASL has the highest capacity to

bring out significant changes in system performance while FO is the key stakeholder who is reported in high importance but it has moderate capacity to bring out changes. Most of government and private institutions who actively involved in the project activities are considered as the primary stake holders. They are with the moderate interest to improve system performance but having less capacity to show up changes in project activities. A very few number of institutions are with a stake in project and having less importance and influence on the project.

## CONCLUSIONS

The socio-economic performance shows a considerable variation among the 11 hamlets within the Medagama Management Block. The origin of the settlers is seemed to be a vital factor for their performance in the new settlements. The literacy level of the adults, and motivation to achieve a better living condition are the other remarkable factors which influence on socio-economic performance variability within the block. In overall, medium socio-economic performance was observed in all hamlets except *Henanigala South*, where the *Adiwasi people* are settled. *Henanigala South* has recorded the least performance in farming. It indicates that it is difficult for the *Adiwasi* people to adopt into farming from their traditional livelihood activities.

Non farming income is considerably high in the area. As an example, majority of the people in this area have involved in non-agricultural work and it contributes to a greater proportion of the household income. Evaluation of performance based on the smallest geographical unit called hamlets within a management block facilitates to identify possible problems associated with low socio-economic performance and this helps to focus on specific management interventions in poorly performing areas.

MASL and FOs are the key stakeholders in the area in terms of enhancing system performance. Other government agencies who are working within the project area have moderate interest to improve system performance but having less capacity to show up changes in project activities.

## RECOMMENDATIONS

Socio-economic evaluation is important to get a feedback of the system performance. However, an irrigation project cannot be evaluated with the use of these indices alone since irrigation system performance is highly influenced by other factors, such as rainfall and climate conditions, cropping patterns and crop water requirement, soil type, management factors, marketing and other monetary factors.

Therefore, overall irrigation system evaluation is needed with overall assessment considering technical and socio-economic indicators. Thus, this system is to be further evaluated by using indices of water delivery performance, financial, productivity and environmental performances.

It is important to assess spatial variability as well as the temporal variability of the performance to identify the improvements of the system performance with time. Multi

temporal maps will facilitate to visualize the performance variations with time. It will be helpful to assess the reasons behind performance improvement or degradation with time.

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