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RCM Analysis on Prepaid Bill Meter (SIRAJ)

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Abstract

As electric energy depletion is one of the biggest concerns of the upcoming era, prepaid bill (SIRAJ) is one of the latest devices to drastically reduce the consumption of energy and cost associated to the consumption. This newly system is introduced to monitor the consumption of energy and boost energy awareness to customers. This particular service facilitates the prepayment and further helps in tracking of the consumer credit balance. The user-friendly system can be easily managed by the end users and the electricity can be monitored by the tip of their fingers. The most important advantage of this particular meter its eco-friendly as its paper free. For the better understanding of the failures occurring in the equipment selected in this coursework an RCM approach is carried out. RCM basically relies on the terminology of preserving the system function. This approach deals with maintenance of the system in a very methodical and analytical manner. A RCM approach was carried out on the prepaid meter; the operational context was discussed accordingly. With the relevant information collected the parameters where analysed and the information and discussion worksheets were formulated. The most important factor was to identify the standards and the practises which were taken place and link it with safety and environmental concerns. The benefits of RCM approach were discussed accordingly, and the function modes were assessed in detail describing all the failure modes associated to it.

Keywords: Siraj; RCM; Energy Consumption; Prepaid Bill Meter; Eco-Friendly

Methodology

The Prepaid meter Siraj was venture started by Mazoon electric to observe the electricity consumption and allow users to use the energy wisely. The display unit depicts like an old age mobile with numbers and keys. Each number has particular function which is further displayed by the monitor. This meter is installed in the asset and connected to the main prepaid meter through cable wires. Both the meters have the same displays and the same readings. Power of the display meter is governed by the main prepaid meter. For emergency purposes the display unit has provision to run on batteries. The meter is easily installed in any part of the asset through a cable (Figure 1).

The meter thoroughly monitors the electricity consumption throughout asset. The display unit as shown in the Figure 1 has buttons from 0 to 9 and #* respectively. Each key denotes a particular function, by the click of the key the value of the reading is displayed accordingly in the monitor. Once the particular meter is recharged with a certain amount which can be attained 24/7 in form of tokens the meter starts monitoring the electricity consumption (Figure 2).

To add the balance to the unit, a token key must be generated by paying the desired amount. Then the key is fed into the display unit by pressing the * key and ending with # key and the amount is added to the unit. The display unit main function is to give each and every detail of electricity consumption. The function modes on every key can be checked on timely manner to keep the record of the consumption energy. The display unit has a critical role in monitoring every spike and notifying the customer of the electricity consumption. The main goal of the asset is to manage their utilities and use the electricity consumption wisely for attaining a reduced electrical cost overall for the asset.

For the better functioning of the display unit a RCM approach was applied. The failure modes were assessed accordingly and dealt with so the maintenance decision could be easily made. The main target was to preserve the system function at all cost. The display unit is designed to have minimum failures for its proper functioning as the electricity consumption is at stake. The backup for the display unit is the prepaid meter itself. So, any failure in the display unit the prepaid meter has the records of the consumption.

As it's a recent development the RCM approach can give a better understanding of the system. The main failures which the display unit aspects are when the balance runs out and the electricity is cut off and blackout is observed accordingly. However, there is cut out of some money of negative Omani Rials but still eventually there is power failure.

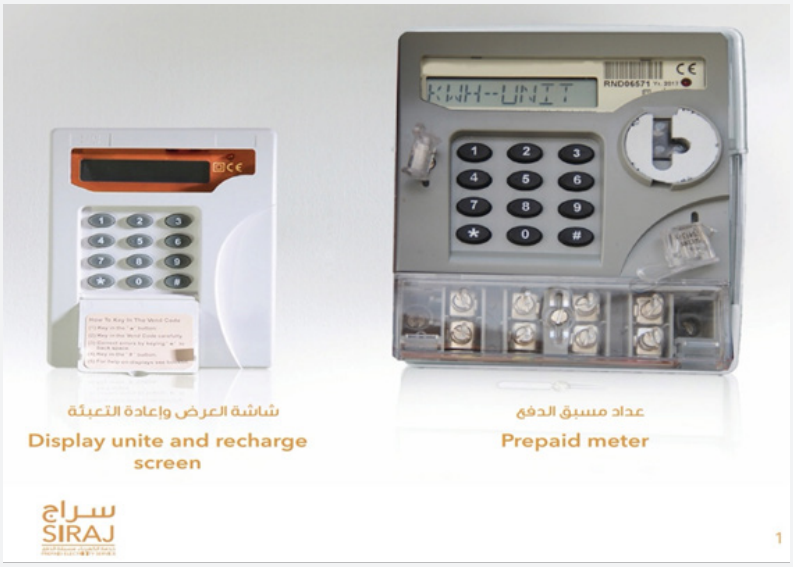
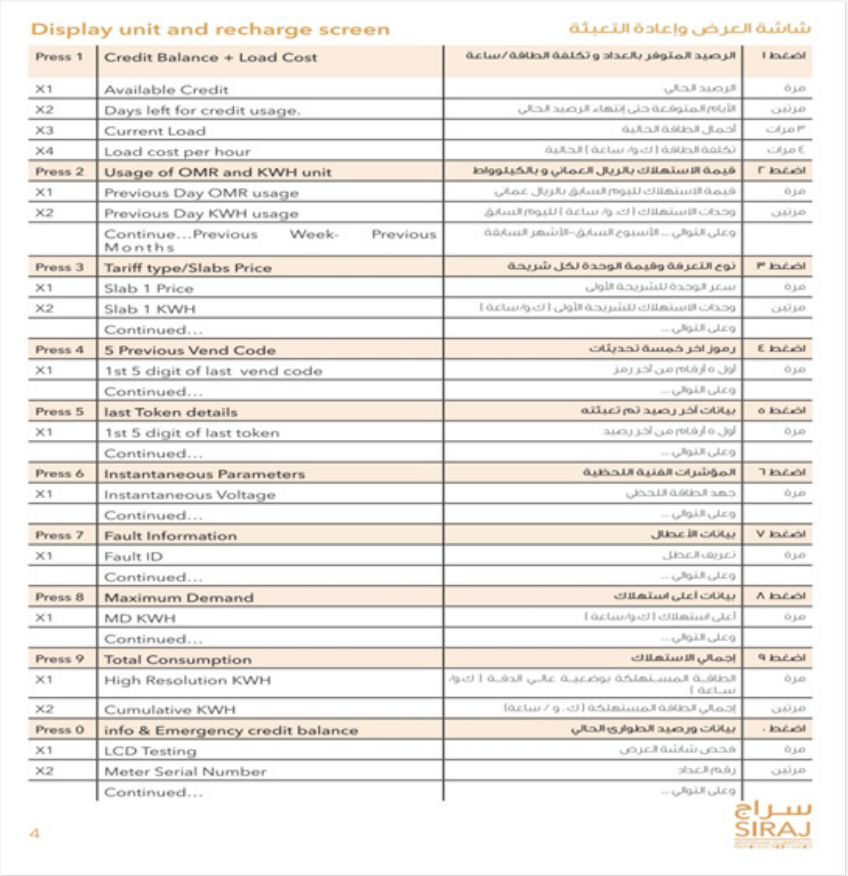


Figure 1: Siraj Prepaid Meter (MZEC, 2020).



Display unit and recharge screen — شاشة العرض وإعادة التعبئة

Press 1	Credit Balance + Load Cost	الرصيد المتوفر بالعداد و تكلفة الطاقة/ساعة	اضغط ١
X1	Available Credit	الرصيد الحالي	مرة
X2	Days left for credit usage.	الأيام المتوقعة حتى إنتهاء الرصيد الحالي	مرتين
X3	Current Load	أحمال الطاقة الحالية	٣ مرات
X4	Load cost per hour	تكلفة الطاقة [ك.و/ ساعة] الحالية	٤ مرات
Press 2	Usage of OMR and KWH unit	قيمة الاستهلاك بالريال العماني و بالكيلووات	اضغط ٢
X1	Previous Day OMR usage	قيمة الاستهلاك لليوم السابق بالريال عماني	مرة
X2	Previous Day KWH usage	وحدات الاستهلاك [ك. و/ ساعة] لليوم السابق	مرتين
	Continue...Previous Week- Previous Months	وعلى التوالي ... الأسبوع السابق-الأشهر السابقة	
Press 3	Tariff type/Slabs Price	نوع التعرفة وقيمة الوحدة لكل شريحة	اضغط ٣
X1	Slab 1 Price	سعر الوحدة للشريحة الأولى	مرة
X2	Slab 1 KWH	وحدات الاستهلاك للشريحة الأولى [ك.و/ساعة]	مرتين
	Continued...	وعلى التوالي ...	
Press 4	5 Previous Vend Code	رموز اخر خمسة تحديثات	اضغط ٤
X1	1st 5 digit of last vend code	أول ٥ أرقام من آخر رمز	مرة
	Continued...	وعلى التوالي ...	
Press 5	last Token details	بيانات آخر رصيد تم تعبئته	اضغط ٥
X1	1st 5 digit of last token	أول ٥ أرقام من آخر رصيد	مرة
	Continued...	وعلى التوالي ...	
Press 6	Instantaneous Parameters	المؤشرات الفنية اللحظية	اضغط ٦
X1	Instantaneous Voltage	جهد الطاقة اللحظي	مرة
	Continued...	وعلى التوالي ...	
Press 7	Fault Information	بيانات الأعطال	اضغط ٧
X1	Fault ID	تعريف العطل	مرة
	Continued...	وعلى التوالي ...	
Press 8	Maximum Demand	بيانات أعلى استهلاك	اضغط ٨
X1	MD KWH	أعلى استهلاك [ك.و/ساعة]	مرة
	Continued...	وعلى التوالي ...	
Press 9	Total Consumption	إجمالي الاستهلاك	اضغط ٩
X1	High Resolution KWH	الطاقة المستهلكة بوضعية عالي الدقة [ك.و/ ساعة]	مرة
X2	Cumulative KWH	إجمالي الطاقة المستهلكة [ك. و / ساعة]	مرتين
Press 0	info & Emergency credit balance	بيانات ورصيد الطوارئ الحالي	اضغط ٠
X1	LCD Testing	فحص شاشة العرض	مرة
X2	Meter Serial Number	رقم العداد	مرتين
	Continued...	وعلى التوالي ...	

سراج SIRAJ

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Figure 2: Function Modes of display unit (MZEC, 2020).

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Results & Discussions

Table 1: Functions of the display unit.

Number	Function Type	Function Statement
1	Primary	To display the values on pressing the keys of display unit
2	Primary	To monitor the electricity consumption and record all the important details regarding the electricity consumption
3	Primary	Recharge of the token and adding the balance to the unit
4	Secondary	The display unit remains in intact position and gets power from the main prepaid meter
5	Secondary	As per the pandemic situation, to prevent any transmission of disease by contacting the keys of the display unit
6	Secondary	To give prompt output and precise reading when commanded for the better assessment of the user

Information Worksheet

Table 2: Information Worksheet.

Equipment Type:		**Siraj Prepaid Meter**				**Asset Name:**	**Display Unit and Recharge Screen**				
Location:		**Main Building**				**Asset Age:**	**/**				
Process:		**Assessment of Display Unit**				**Date of Study:**	**July 2022**				
Equipment/ Identifier	**Function**		**Functional Failure**		**Failure Mode/ Cause**		**Effect of Failure**	**Failure Cost**	**Severity**	**Occurrence**	**Detection**	
Primary	**1**	To display the values on pressing the keys of display unit	**A**	No display given on the appropriate keys assigned	**1**	Error in the display unit	User will not get the information related to the electricity consumption	User will face major loss to due to the inavalibilty of any data and would not record to any the details related to electricity consumption. Minor repair can be expected	6	4	3	72
					2	Malfunction of the display unit due to mishandling the keys						
					3	The keys might be jammed due to dirt	The display unit will not interpret the command given by the user					

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Primary	**2**	To monitor the electricity consumption and record all the important details regarding the electricity consumption	**A**	System disfunction and not accessing any details	**1**	There would be a error in the display unit mother board/Memory Unit	Total error in the display unit and the display unit may not monitor any reading	User will face major loss to due to the inavalibilty of any data and would not record to any the details related to electricity consumption. This will further effect on saving the energy and cost. Cost of major repair can be expected	7	5	4	140
					2	Miswiring of the display unit and problem in the cable	Invalid data which may lead to inaccurate results					
			B	Error in readings and in accurate display of reading	**1**	The display unit might have some unexpected internal error						
Primary	**3**	Recharge of the token and adding the balance to the unit	**A**	Electricity cut out due to insufficient funds	**1**	Error in recharging the token	The display unit not accepting the token. Showing error in the display unit	Until the user Rectifies and fills in the right token code the balance will not be added leading to electricity cut out. Major failure and have to be addressed immediately	8	5	4	160
					2	Entering the number and misplacing the digits to the unit	Can be rectified by *key otherwise showing error in the display unit					
			B	Display unit would sound an alarm every two hours in reminder	**1**	Display of insufficient balance and the sound of a alarm	Total power cut of electricity	User will have no electricity until recharged. Major failure and have to take full precaution				
Secondary	**4**	The display unit remains in intact position and gets power from the main prepaid meter	**A**	The unit falling down from a height	**1**	Improper installation by the technician and no proper support	Damage to the display unit/ May lead to damage of display/ Damage to the supporting wall	Replacement of the display unit/ Time wastage of the new parts/ Renovation of the walls	5	3	5	75
			B	Loss of power from the prepaid meter/unable to read any readings	**1**	Due to some loose connection from the cable connected to display unit	Complete shutdown of Display unit/ Can have adverse effect on the display unit reading	Backup of the reading can be done by installing on batteries to the display unit/ User should get the backup readings directly from the prepaid meter which will be time consuming	4	2	2	16
					2	Improper installation of cable						
					3	In case of electrical failure						

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Secondary	**5**	As per the pandemic situation, To prevent any transmission of disease by contacting the keys of the display unit	**A**	Spread of diseases from the contact of person using the keys of Display unit	**1**	Spread of infection by sick user to other user	Can create a chaotic situation which deals with quarantine leaves/ As disease could be contagious the whole asset would be at stake/Staff leaves	Temporary shutdown of the asset due to sanitization of every part of the asset/Due to the pandemic situation the havoc created in the asset/ Proper protocols related to the situation as per the company guidelines related to health and safety	7	5	5	175
Secondary	**6**	To give prompt output and precise reading when commanded for the better assessment of the user	**A**	Delay of response from the Display unit	**1**	Delay in processing the request due to slow internal processor	User will have to wait for the process. Which will be time wasting	Quick actions related to energy consumptions could expect a delay/ Processor could be checked upon	5	4	3	60
			B	Inaccurate reading given by the display unit	**1**	Damage to the unit memory	Time delays for the users and inaccurate reading for the users	Will have to replace the display and the unit memory / Create a difference in readings and create an impact on the energy consumptions				
					2	Damage to the display			6	3	3	54

Decision Worksheet

Table 3: Decision Worksheet.

RCM DECISION WORKSHEET			**System**				**Siraj Prepaid Meter**									
			Sub system				**Display Unit**									
Information reference			**Consequence evaluation**				**Technical Feasibility**			**Default Tasks**			**proposed task**	**Task interval**	**Performed By**	**Current maintenance**	**RCM Benefit**
F	**FF**	**FM**	**H**	**S**	**E**	**O**	**H1 S1 01 N1**	**H2 S2 O2 N2**	**H3 S3 O3 N3**	**H4**	**H5**	**S4**					
1	A	1	N	N	N	Y	N	Y					The error should be addressed immediately. For the restoration of the display unit. Repairs should be carried out	Once	Technician	Nil	The error should be solved to eliminate the chances of failure mode. To attain the maximum efficiency of the unit.

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		2	Y	N	N	N	Y					The keys should be handled carefully and delicacy. Training by presentation to all the workers should be given on the use of display unit.	Daily	Admin	Nil	The display unit should be used in a appropriate manner for proper functioning.
		3	Y	N	N	N	N	Y				The cleaning staff should make sure the display unit is cleaned and the keys should be maintained properly so the dust is not accumulated on it	Daily	Cleaning Staff	Nil	With minimum cleaning of the keys, Failures related to display unit can be drastically reduced
2	A	1	N	N	N	Y	N	Y				The display unit should be addressed and the parts should be replaced	Once	Technician	Nil	To avoid the complete failure small parts are replaced.
		2	N	N	N	Y	Y					The wiring should be checked and replaced if necessary	Once	Admin	Nil	display unit malfunction is avoided
	B	1	Y	N	N	Y	Y					Display unit should be examined and reset to check for errors	Daily	Technician	Nil	To minimize the extent of failure
3	A	1	N	N	N	Y	N	N	Y			Display unit should be recharged with the token until the balance runs out	On the basis Credit	Admin	nil	To avoid the major failure
		2	N	N	N	Y	Y					The keys should be properly checked and entered to the display unit	On the basis Credit	Admin	nil	To ensure for proper function of the electricity
	B	1	N	N	N	Y	N	N	N	N	N	N	To be addressed immediately and the token should be recharged before the electricity cuts off/ Redesign of the system	On the basis Credit	Admin	To find a alternative method	If not addressed would lead to the complete failure of the system

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4	A	1	Y	N	N	N	Y						The unit should be properly installed/Visual inspection of the location to avoid future errors	Once	Technician/ Admin	Once	Reduction of Unnecessary times waste and elimination of failures
	B	1	N	N	N	Y	Y						Connection should be properly checked and made sure of rectifying of loose connections	Daily	Admin	nil	Elimination of further failures associated to it
		2	Y	N	N	Y	N	Y					The cables should be reinstalled and checked for the proper power	Once	Technician	Once	To make the power supply intact and reduction of failure
		3	Y	N	N	Y	N	Y					The backup of the power supply from the prepaid meter should be functional and the batteries of the display unit should be installed	Monthly	Admin	nil	Elimination of further failures related to power function
5	A	1	N	Y	N	N	N	Y					There should be seminars related to health safety and monthly checkup of officials. The latest guidelines of who related to health pandemic of all protocols to be followed/ Sanitation of the display unit is a must.	When Required	Health and Safety Team/ Cleaning Staff	Run to failure	For the securement of every employee/ Reduction of the spread of diseases
6	A	1	Y	N	N	N	Y						Display unit could be checked/ A small reset to the display unit could refresh the unit	Once	Technician	Once	Time delay is reduced/ Better functioning of the display unit
	B	1	Y	N	N	Y	N	Y					The repair to the display unit should be taken under consideration and fixed on the spot.	Once	Technician	When Required	For reducing the failures associated to display unit
		2	Y	N	N	Y	N	Y									

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Conclusion

To conclude the article a vivid analysis was discovered by applying the RCM approach to the display unit. Further with the help of information worksheet a list of failure modes was and loop holes of the unit was discovered. The decision diagram gave the apt solutions to those failure modes and many critical functions were assed accordingly. The prepaid meter is rather new to the market and is a very efficient but still many drawbacks which were discovered are discussed in detail through information worksheet. If proper protocols and timely maintenance carried out the prepaid meter can show excellent efficiency. The most important factors which were looked in this article were the display unit and its failures. Two most important which should be addressed is the catastrophic failure which leads to electricity cut out and the ease of monitoring the readings by the users.

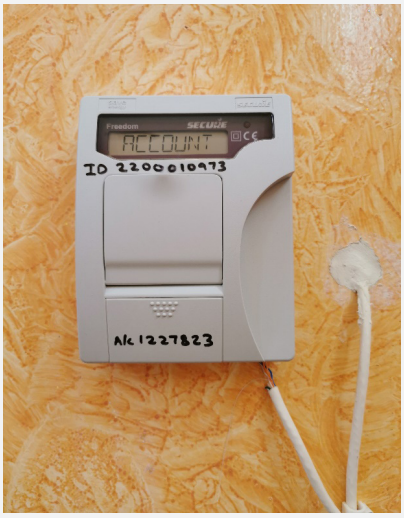
Recommendations

Future work can be categorized as follows:

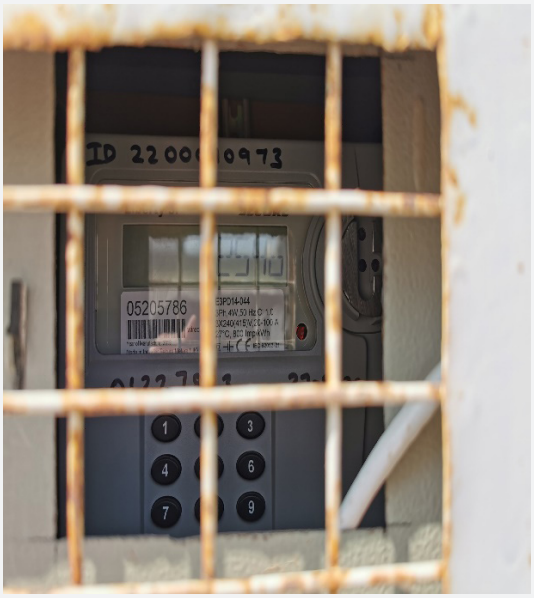
I. For easy monitoring the display unit details can be accessed remotely by mobile phones or other mediums

II. There should be alternative introduced if the balance is low and instead of power cut an alternative solution can be thought upon.

Appendix:



Appendix 1: Display Unit of the Prepaid Meter.



Appendix 2: The Main meter.

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