SMS Based Notification System For Identifying The Faulty Equipment's Of Blast Furnace

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Abstract: Mobile network communication system offers services that have made everyone's life a simple and smarter. The evolution of short message services (SMS) has made information available to individual located far away from the sender. This paper describes the application of SMS based system to identify the faulty equipment's of blast furnace based on the defined limits. If the individual field equipment's fails or crosses the set limit, a SMS is generated and communicated to the end user and is subsequently escalated after a predefined interval of time.

Index Terms: short message services, mobile technology, communication, fault, field equipment's

INTRODUCTION

There are various field equipment's in blast furnace important for the stable operation of plant. Any delay in the identification of the faulty equipment will lead to the time for resolving the equipment as well. Now-a-days with the growing use of mobile phones, a system can be developed that can communicate anything over Short media message, if integrated with the desired application. Short Message Services commonly known as SMS is a feature of second generation mobile technology which has emerged as a popular tool for delivery of short messages over the mobile networks. Perhaps, the SMS based system is most widely used method to communicate the information and also broadcast the general communication to a larger group of peoples after phone calls and mailing system. The reason for wider popularly of messaging system is that it not only saves time but also increases the working efficiency in cases where the information is to be communicated urgently without interacting the concerned team. The most powerful solution is if SMS functionality is added to all the existing application. Thereby, user will be able to receive SMS messages from the IT environment. In this way the communication among different departments of company can be improved and can be easily in touch, even with customers and business partners. Using SMS technology, it is possible to forward information such as date and time of meetings, or custom instructions.

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Furthermore, to improve the speed of communication flow it is possible to forward the sent or received email messages via SMS text messages. The applications of using the SMS technology have really made the world small. Adewale [1] and co-workers have developed java based automated lecture alert management system, with the view of proper time management for effective lecture delivery for university with limited lecture halls, time and people. The java program as reported is integrated with GSM network through USB port of a PC and GSM modem. Another program is developed in C# to schedule this application that triggers SMS at particular times. Using this application, the information regarding the availability of the lecture halls and reminder alerts can be reached easily irrespective of the location of the individuals. Similarly Osama Salameh [2] has reported a mobile-phone SMS-based notification system to assist diabetic patient. This application can connect physician to their patients thereby making it a self-management of illness by serving as an educational tool for patients. The objective of this application is to track the patient's health progress and provide guidance for better health improvement. The system sends daily prescription to the patient, reminds the patient about doses, etc. Deepak Kumar [3] has developed a software application for android mobile platform using which the mobile phone can behave like an intelligent device. It shows how various features can be automated by SMS. Using this application, user can perform various operations in its mobile even if mobile is remotely located or is misplaced or lost using location based services. Though various useful application can be performed using this application, only some of the features are automated while others are to be initiated manually. Supe [4] has reported the development of similar system. SMS based system is also used in various universities for conveying the necessary information. L. Naismith [5] has reported the application of SMS services to promote administrative communication to higher education in the University of Birmingham. Using this application the staff members can ubiquitous exchange text messages with their students and subsequently students are also benefitted by effectively acting on the received text messages. SMS based system are not only popular among students but is also useful for the house hold purposes [6]. Mane [7] has reported the use of hand-held mobile phones for remote control of systems and home appliances in a wireless and remote fashion for a great convenience to many people. Using this, one can do remote operation without directly accessing the host of a home appliance such as fan, lamp, television, washing machine, air-conditioner, security

system, set top box, light etc. Olusanya [8] and Ahmad [9] have described the implementation of result alert system that provides examination results to students using email and SMS via mobile technology, thereby overcoming the limitation of making the examination results and grades available to the student. Similarly Ismail [10] have reported the similar system for the student's mass communication. Although, various SMS based application [11], [12] has been developed for use in university for proper lecture management, administrative communication in institution, library services, hospitals for reporting of various laboratory test results, vacant car parking alert, entertainment, event notification, etc. SMS based system is far more than just a technology for these applications. The scope of utilizing this technology for industrial purpose can by far prove to be the best application of the system. The present paper explains the development and implementation of SMS based system that can identify the faulty equipment's based on the prior limits set for the equipment. If the individual field equipment's crosses the set limit, a SMS is generated and communicated to the end user based on the escalation matrix provided by maintenance team.

WORKING PRINCIPLE

In the present work, the SMS based system for monitoring the critical field equipment's are designed to work as an application. The system is managed by an administrator who is responsible for addition and deletion of SMS receivers, formulating the rules for sending SMS, scheduling the SMS frequency, creating the escalation matrix. The system is designed using C# language in IDE environment. The database of the system is designed using Oracle database. The application runs with the executable file that operates at a regular interval of one minute. The SMS based system is integrated with the SMS gateway using application program interface. The SMS system triggers the SMS and inserts it into the Oracle database which is message gateway. This server is integrated with the main server which receives the message and then sends it to various users set by the application. The server where all the plant related data are stored is known as 'Plant Server'. The SMS based system is named as 'Application'. The server where application runs is named as 'Application Server'. The server where data related to plant critical equipment's are stored is named as 'Database Server'. The server from where SMS is send to the list of senders is named as 'SMS Server'. The critical parameter of all the field instruments are retrieved from the plant server and stored in database server. The details of the various servers are shown in Figure 1. The basic principle of generating the SMS based on the abnormal condition is demonstrated in Figure 2. The continuous production of hot metal in blast furnace requires the adequate availability of raw material in stock house. It can be seen from Figure 2 that the reduction in the bin level is monitored by the flowchart shown in figure. The details of the procedure for generating SMS are shown in Figure 3. The SMS based alert notification is developed based on the concept of three-tier architecture, wherein the three-tier corresponds to three groups of peoples. There are 3 groups formulated and the SMS is sent to them accordingly. Group 3 is the lowest level people who are primarily responsible for maintaining the desired condition. Group 2 are those peoples who are indirectly related whereas group 1 are those set of peoples are mainly administrator and working to maintain all the parameters in the range. Since the blast furnace is supplied by raw materials from various plant such as sinter plant, pellet plant, coke plant. The unavailability of the any raw material leads to throttling of blast furnace. Therefore the present system sends message not only to the blast furnace peoples but also to the related department. For instance, when the pellet bin level is reduced the SMS for the inadequate bin level is automatically sent to the group 3 of the sinter or pellet plant department and to the blast furnace department.

RESULTS AND DISCUSSION

Figure 4 shows a typical screenshots taken from a mobile handset; showing the SMS received by the user during the abnormal condition. It can be seen from Figure 4 that the text of SMS consists of three parts viz. the alarm event information, followed by the time of occurrence of event and senders name. The alarm event information is usually configured in the system in prior, the event time is the time at which the alarm is triggered and senders name is the name of the system through which SMS is sent. The present system is designed such that many more equipment's can be monitored and SMS can be triggered by setting up the rules. Though the system is designed for monitoring the field equipment's of blast furnace, it is possible that the same principle can be applied to any other plant processes as well. Table 1 shows the process and product quality alarm conditions while Table 2 shows stock house bin level alarm conditions. The SMS is sent to the individual based on the escalation matrix. All the SMS generated by the present system is stored in the database server and can be retrieved in future for analysis. It is believed that more number of SMS generations indicates more frequent failure of equipment. Therefore it is necessary to record all the SMS generated by the system. The system is designed such that the number of SMS generated for the faulty equipment is calculated automatically and a pareto-chart is prepared as shown in Figure 5. The pareto-chart shows equipment-wise frequency of SMS generated in descending order. Using this it is possible to monitor the performance of the field equipment on regular interval. In absence of the present system, the traditional practice of monitoring the field equipment's was very cumbersome. An individual had to regularly monitor the condition of the equipment by physical inspection. The time required for the identification of the faulty field equipment used to consume a significant amount of time. Instead, the present system has eliminated the need of physical inspection of faulty equipment and now it is possible for an individual located remotely to monitor the condition of equipment. Moreover, when field equipment fails the cycle time of rectification was higher. This is so because the individual who has identified the faulty equipment may or may not by the skilled in resolving the faulty equipment. In this instance the concern used to be escalated and referred to the expert, which require additional time. With the present system, if the faulty equipment is identified by the system and if remains defective for a certain interval of time, the SMS is automatically escalated to the higher management and triggered to the expert. Figure 6a and 6b show the pareto-

chart of the SMS generated in two different time interval Q1 (April'16 to June'16) and Q2 (July'16 to Sep'16). It can be seen that the number of SMS generated in figure 6b are comparatively lower that the number of SMS shown in figure 6a. Navale [13] has also reported the system for monitoring the liquid petroleum gas leakage that alerts the relevant person about the leakage of gas through SMS. The present SMS based system is also integrated with various blast furnace process models using which the alert message regarding the abnormal process conditions are sent. The present system utilizes the results derived from various process models such as rise in the hearth liquid level [14] and leakage in tuyere nose cooling circuit [15].

CONCLUSION

The SMS based system is developed for monitoring the faulty equipment' and is implemented in blast furnace area. The SMS based system guides the concerned person about the equipment failure immediately when a fault is identified, therefore it reduces the cycle time of identification of faulty equipment. The present system has reduced the number of faulty equipment.

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Figures

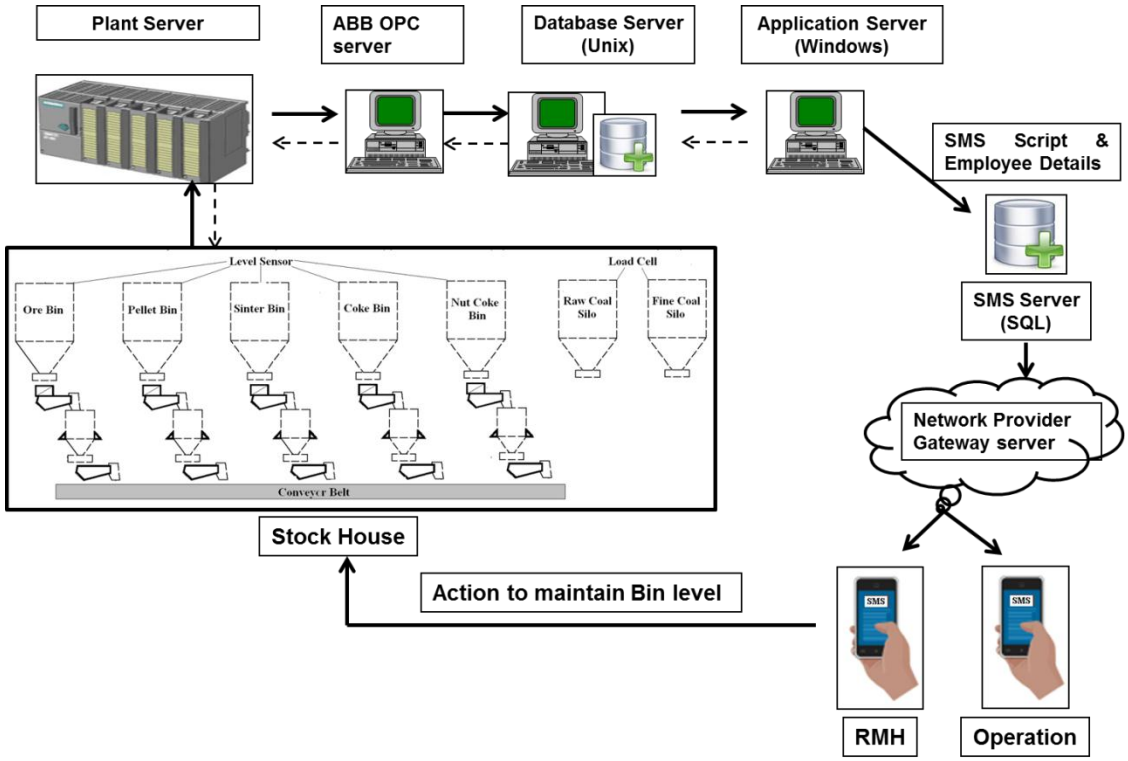


Figure 1: *Schematic architecture of the SMS based system*

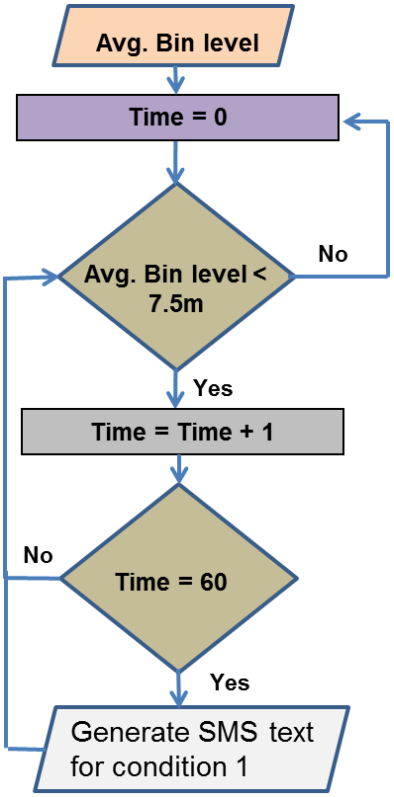


Figure 2: *Principle of generating the SMS based on the abnormal condition*

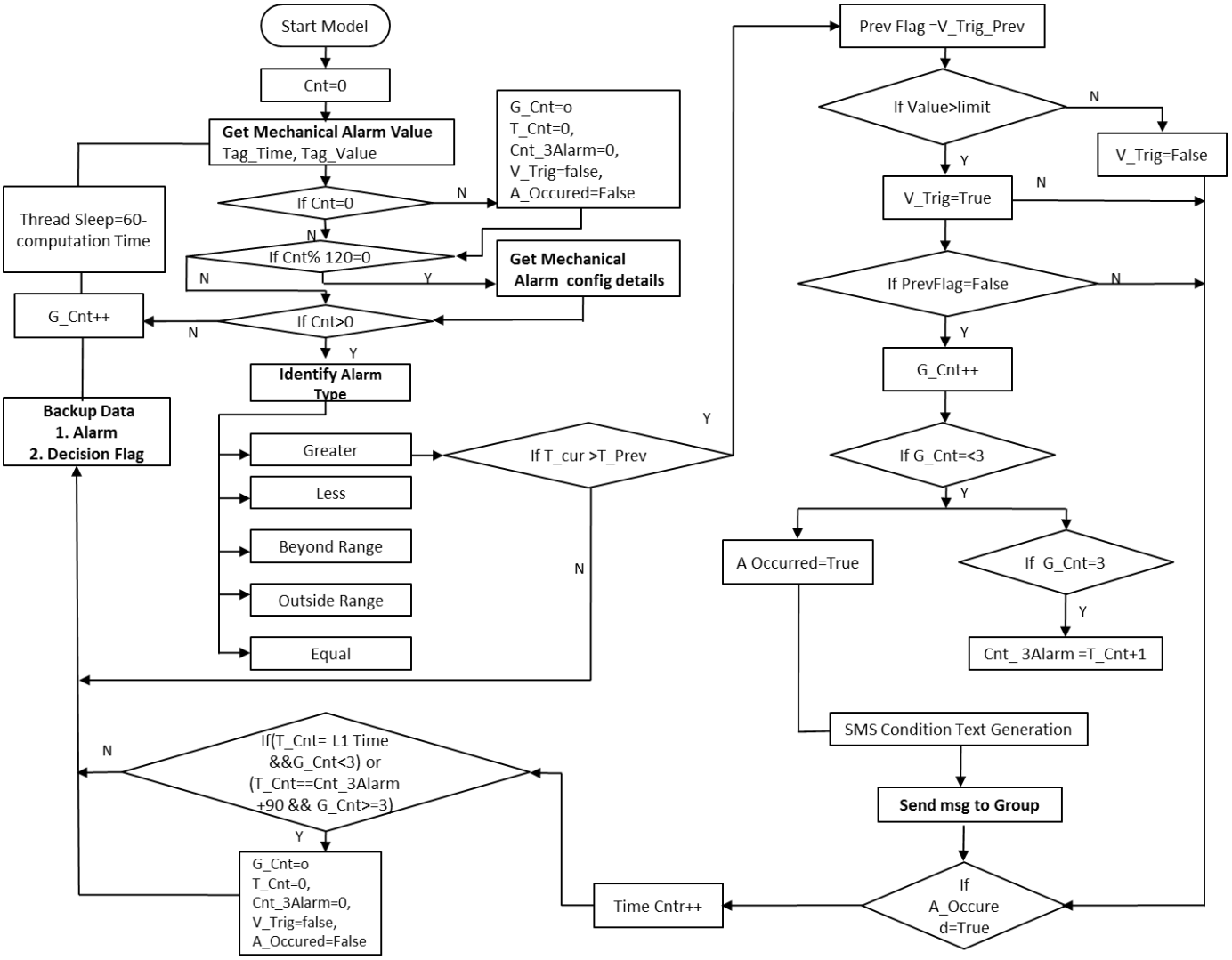


Figure 3: *Details of the procedure for generating SMS*

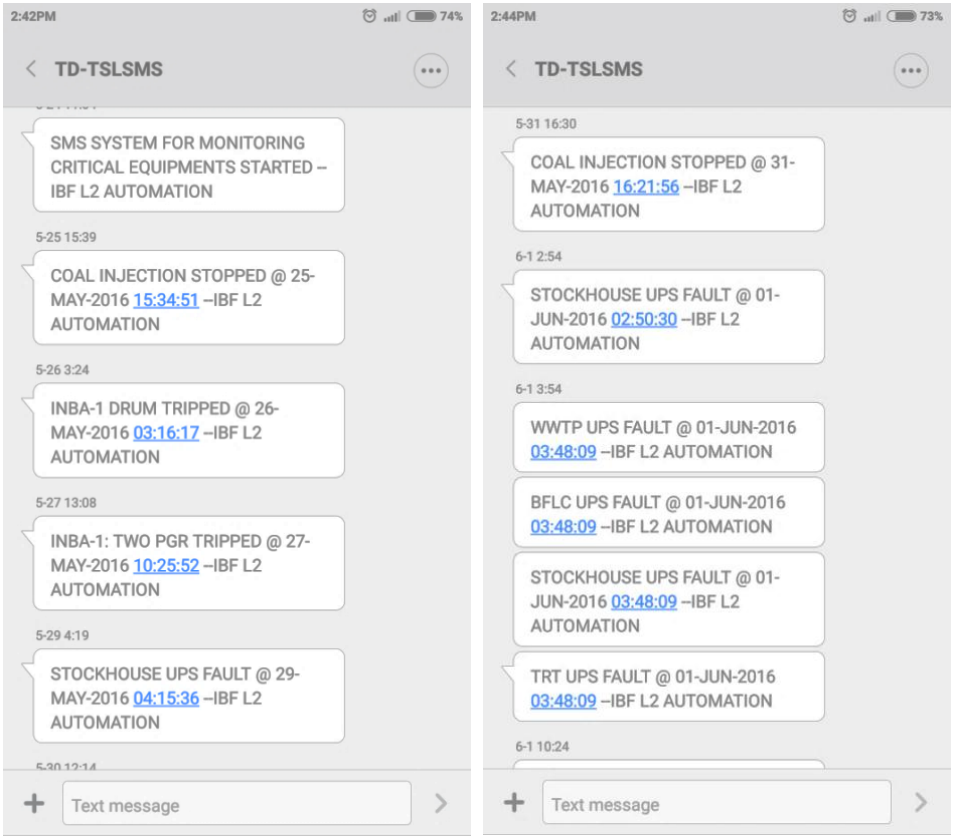


Figure 4: *Typical screenshots of SMS taken from a mobile handset*

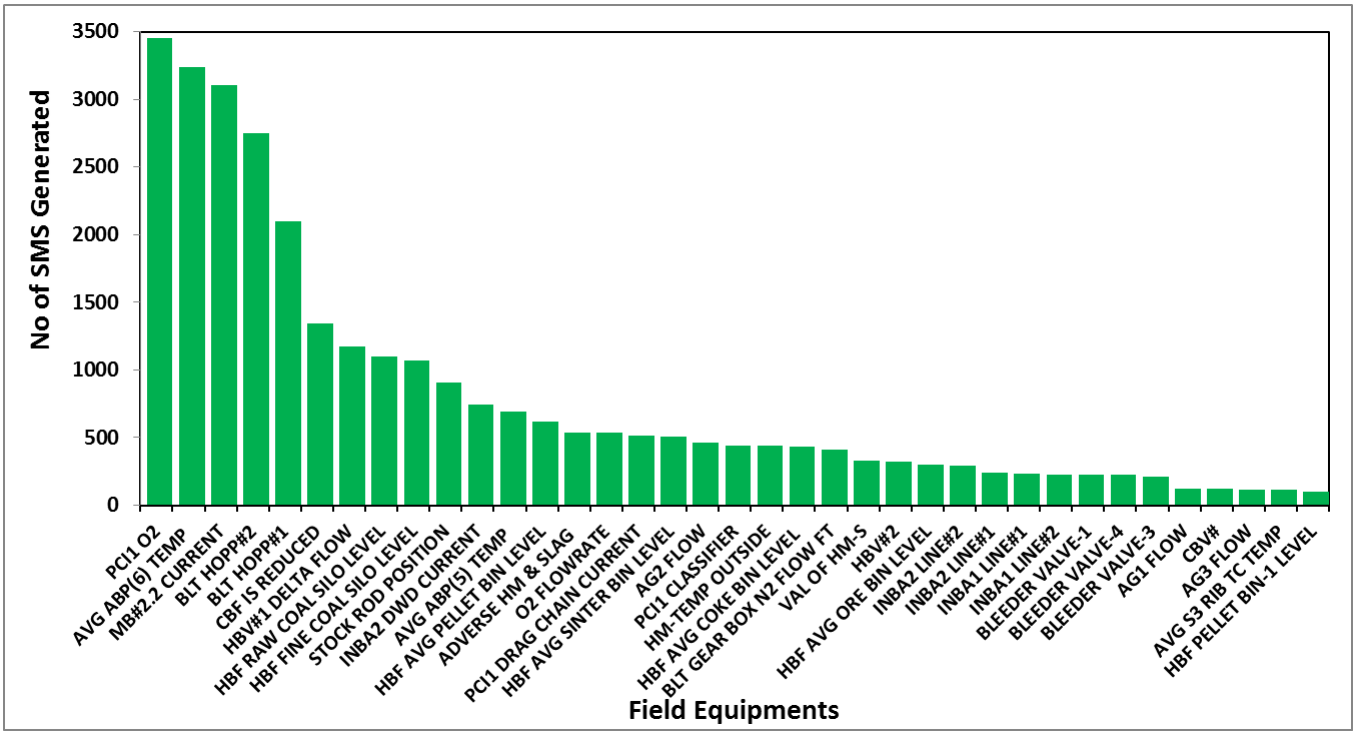
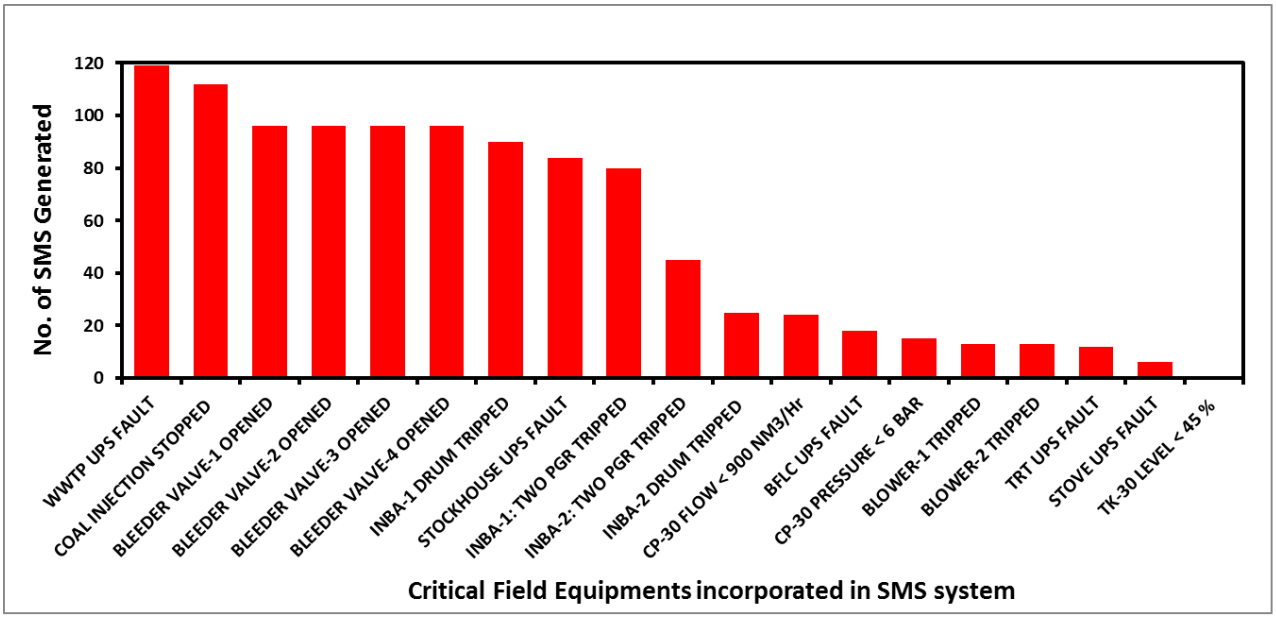


Figure 5: *Pareto-chart of the number of SMS generated*



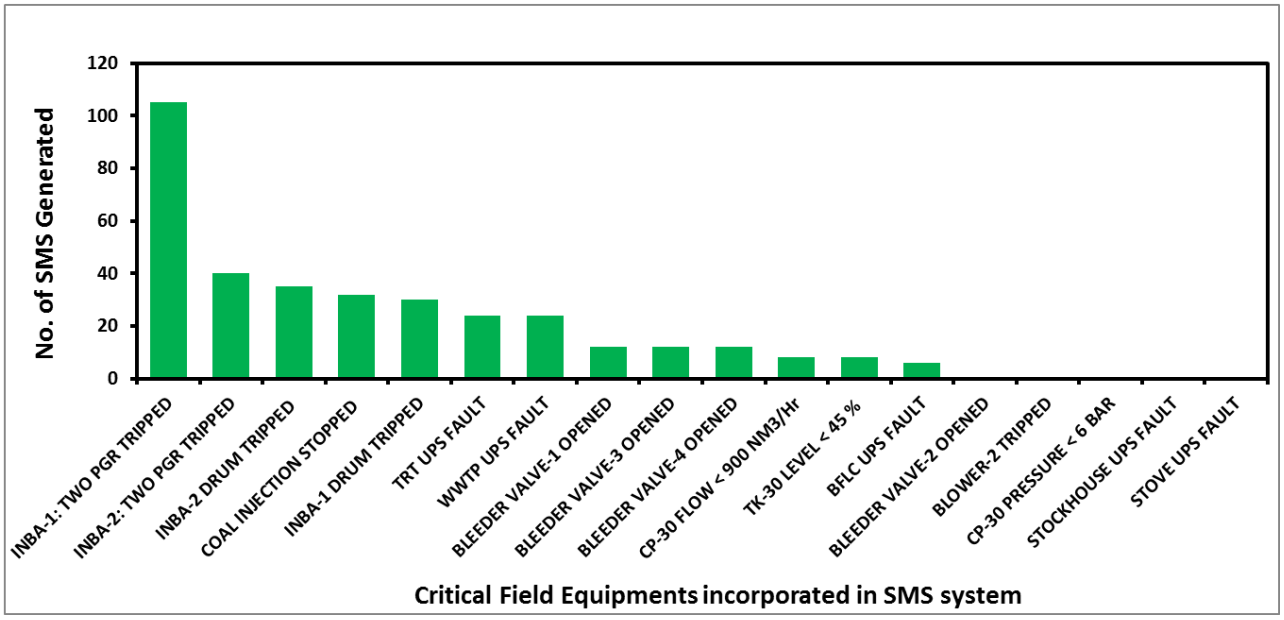


Figure 6: a. *Pareto-chart of the number of SMS generated in Q1*
b. *Pareto-chart of the number of SMS generated in Q2*

S.NO.	Alarm	Alarm Conditions		
		Group 3	**Group 2**	**Group 1**
1	Avg. Temp. of all S3 ring Rib TC	Avg. Temp < 200^{0}C from last 2 hr	Avg. Temp < 200^{0}C from last 6 hr	Avg. Temp < 200^{0}C from last 10 hr
2	Avg. Temp. of ABP 5	Avg. Temp < 450^{0}C from last 1 hr	Avg. Temp < 400^{0}C from last 2 hr	Avg. Temp < 400^{0}C from last 4 hr
3	Avg. Temp. of ABP 6	Avg. Temp < 500^{0}C from last 1 hr	Avg. Temp < 450^{0}C from last 2 hr	Avg. Temp < 450^{0}C from last 4 hr
4	Stock Rod Position	Stock Rod Position > 200 cm	Stock Rod Position > 200 cm for last 1 hr	Stock Rod Position > 200 cm for last 2 hr
5	Reduction of O_2 flow rate	O_2 flow rate reduced by more than 15 %	O_2 flow rate reduced by more than 15 % for last 1 hr	O_2 flow rate reduced by more than 15 % for last 2 hr
6	Pulverized Coal Injection	Actual PCI reduced by 40% than Set point	Actual PCI reduced by 40% than Set point for last 30 min	Actual PCI reduced by 40% than Set point for last 1 hr
7	Bleeder valve Open	Bleeder valve open	Bleeder valve open	Bleeder valve open
8	Make up time Cooling Circuit 2	Last Make up time < avg. makeup time of last three cycles	Make up time of last 2 cycle < avg. makeup time of last three cycles	Make up time of last 3 cycle < avg. makeup time of last three cycles
9	Hot Metal Temperature	HM temp not between 1480-1540^{0}C for last analysis	HM temp not between 1480-1540^{0}C for last two analysis	HM temp not between 1480-1540^{0}C for last three analysis

10	Hot Metal Silicon	Si > 1.2% for last analysis	Si > 1.2% for last two analysis	S > 1.2% for last three analysis
11	Hot Metal Sulphur	S > 0.1% for last analysis	S > 0.1% for last two analysis	S > 0.1% for last three analysis
12	Bin level of same material	Bin level < 55%	Bin level < 55% for last 2hr	Bin level < 55% for last 3hr
13	INBA any 2 PGR Tripped	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
14	INBA Drum Tripped	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
15	PCI UPS Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
16	Coal Injection Stop	If stopped for the 1st time	If stopped for the 2nd time	If stopped for the 3rd time
17	CP 30 Flow Down	If < 900 Nm^3/hr from last 15 mins	if < 800 Nm^3/hr from last 15 mins	if < 500 Nm^3/hr from last 15 mins
18	CP 30 Pressure Down	If < 7 Bar from last 15 mins	If < 6 Bar from last 15 mins	If < 5 Bar from last 15 mins
19	WWTP Ups Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
20	Stove Ups Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
21	BFLC UPS Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
22	Blower Trip	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
23	Stock House UPS Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
24	TRT Ups Fault	If tripped for the 1st time	If tripped for the 2nd time	If tripped for the 3rd time
25	BLT Hopp Mat Disch Time	If <115 seconds for the 1st time	If <115 seconds for the 2nd time	If <115 seconds for the 3rd time
26	Conveyor belt Temperature	If >70 °C from last 15 min	If >70 °C from last 30 min	If >70 °C from last 1 hour

Table 1: *Process and product quality alarm conditions*

S.No.	Material	Bin	Alarm Conditions		
			Group 3	Group 2	Group 1
1	Ore	OB#1, OB#2, OB#3	If Average bin Level < 7.5 mts for >30 min	If one out of three bins < 5 mts for > 30 min	If two out of three bins < 50 %
2	Pellet	PB#1, PB#2, PB#3	If Average bin Level < 7.5 mts for >30 min	If one out of three bins < 5 mts > 30 min	If two out of three bins < 50 %
3	Sinter	SB#3, SB#4, SB#5, SB#6, SB#7, SB#8	If Average bin Level < 7.5 mts for >30 min	If two out of five bins < 5 mts (excluding SB#6) for >30 min	If three out of five bins < 50 %
4	Coke	CB#1, CB#2, CB#3, CB#4	If Average bin Level < 7.5 mts for >30 min	If one out of four bins < 5 mts for >30 min	If three out of four coke bins < 50 %
5	PCI Raw Coal	Raw Coal Silo	If Average bin Level < 350 tons for >30 min	If Average bin Level < 300 tons > 30 min	If Average bin Level < 250 ton
6	PCI Fine Coal	Fine Coal Silo	If Fine Coal < 450 tons for >30 min	If Fine Coal < 400 tons for >30 min	If Fine Coal < 300 ton
7	Nut Coke	Nut Coke	Nut Coke Bin level< 75% for last 30 min	Nut Coke Bin level< 55% for last 30 min	Nut Coke Bin level< 55% for last 1 hr

Table 2: *Stock house bin level alarm conditions*