CHAPTER 6

FINDINGS, SUGGESTIONS, LIMITATIONS AND FUTURE DIRECTION
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6.1 INTRODUCTION

Learning is disconnected from practical implementation so the students do not find any relevance of what they learn in the institute and the life which they lead in Industry. To take an example, subjects like “Emerging Trends in Information Technology” is taught theoretically and students are unaware about the actual working of the technology. If someone takes initiative to purchase some new technology or device, the question comes in the mind of the authority that whether it is beneficial for the institute? , which is not wrong, but due to this fact the staff is unaware about the technology and so the subjects are taught theoretically in most of the cases. If a student from MCA or any other professional technical course develops a project, MBA students can market it or can find out the costing for the product, can take the feedback of the product from the prospective users, so on and so forth. The education in the professional institute thus should encourage creative thinking and concept understanding, students should be motivated to do something new, so that the projects developed by the students would not be a dummy project but could also be useful from Industry point of view.

Technology is a blessing if used in correct way. The technology exists to help the mankind. The very first cause of any discovery is the need. If one uses the technology in a correct way it can do wonders.
6.2 EFFECTIVENESS FOR AN INSTITUTE

Definitions of effectiveness are many but after the critical study and analysis of the secondary data and after collecting the data from 372 valid responses from Director, Teaching staff, Office-In-charge, System Administrator and Librarian from 18 MCA Institutes following are the findings for the working effectiveness of the Institute.

6.3 FINDINGS

For every respondent, the questionnaire was framed in such a manner so as to collect the General Information about the respondent, information related to work, use of Automatic Identification and RFID.

The respondents answered the questions based on the processes which enabled the researcher to find the working effectiveness of the institute. For the above processes the parameters for effectiveness are decided by the researcher based on the constituent functions already mentioned in the chapter 3

6.3.1 Findings from the general information

The researcher asked general information about the respondents in every questionnaire. The findings and the conclusions drawn from the responses of every respondents are given in this section.
6.3.1.1 Director

Directors are the decision makers of the institute, so the questions were based on their future decisions, their thoughts about implementing the RFID technology in various constituent functions.

(A) Findings

It was seen from the data collected that the number of students were increasing day by day since the institutes are going for additional intake of students.

(B) Conclusion

As per the norms set by AICTE\textsuperscript{1}, the faculty or teaching staff requirement for any professional course is dependent on the student intake. In addition to this, the number of books in the library and computers in the computer laboratory are also dependent on the student intake.\textsuperscript{2}

Thus as the number of students will increase in the Institute, the teaching staff, assets like projectors, computers, books in the library too would be increased. In turn the processes related to managing the students’ related data will increase more over if the staff, assets, books in the library would increase the processes related to these also would increase.
6.3.1.2 Teaching staff

Teaching staff actually interacts every day with the students in class room. They have major role in the working of the Institute effectively. To understand their views on day to day activities or working of the institute thus becomes very much important.

(A) Findings

All the teaching staff respondents from which the data was collected are working in the respective institute on full time basis. It is also understood that the incoming and outgoing timings of 55.18 % from teaching staff does not match with the office timing i.e. they either come before the office opens or go after the office closes. (Reference: Table no. 4.4.2). It is also noticed at the time of interaction that the timing of all the teaching staff is not fixed, every semester depending upon the time table set and the subjects allotted to the staff, the timing may change.

(B) Conclusions

It can be concluded from the above findings that the working hours of majority of the teaching staff of the institutes do not match with that of the office. Due to which the office staff is not present to monitor the late-comers.

6.3.1.3 Office–In-Charge

The general questions asked to the office-In-Charge are based on the general institute information, office timings etc. The office staff is also
responsible for asset checking, fee related issues, mess bills etc. so the related questions were asked.

(A) Findings

It is found out that 94.44% of Institutes, along with MCA also run other full time courses recognized by University of Pune like MBA, MPM, MMM or MCM (Reference: Table No.4.2.1).

The office hours of 88.89% Institutes do not match the institute timings (lectures timings). Meaning the lectures either starts before the office opens or lectures ends after the office closes. (Reference: Table no. 4.4.1)

94.45% institutes have their own hostel and mess and the mess is run by the mess contractor.

(B) Conclusions

For any accreditation, certification from ISO, NBA or any Industry (for Institute Industry Alliance) administrative reports are required, these reports can be easily produced efficiently and accurately using RFID in various processes.

6.3.1.4 System Administrator

Every professional Institute has computers now which are in network. Internet has become a need thus there is a need of a System administrator in every Institute.
(A) Findings

In all 77.78% Institutes have branded server and 100% institutes use only MS Windows Operating System and 66.67% use Linux in addition to Windows.

It was also seen that 100% System Administrators were aware about the RFID technology or at least heard about it (Reference: Table 4.10.1).

(B) Conclusions

The infrastructural facilities show that RFID implementation will not be difficult for the institutes. Some devices work on specific Operating systems, the collected data shows that the Institutes are using more than one Operating system.

6.3.1.5 Librarian

Library is a place which is open more than the office timing and this is a place where the students visit after the lectures, thus librarian is also having much interaction with the students as well as staff.

(A) Findings

The libraries of 100% institutes open before the office opens or closes after the office closes. This shows that there is no body to
monitor the incoming and outgoing timings of librarian and the library staff.

Total 44.45% of libraries have implemented bar coding or in a process of implementing it (Reference: Table 4.8.2). 100% librarians were aware about the RFID technology or at least heard about it. (Reference: Table 4.10.1)

(B) Conclusions

The awareness of RFID is 100%, so implementing the technology will not be difficult.

6.3.2 Work related findings

The findings under the work related questions are presented below with respect to the work or the constituent function of the Institute instead of presenting them with respect to the specific respondent.

I. Students’ attendance in class room & computer lab

The Institutes need the attendance of the students at various locations like class room, Laboratories and reading hall. The attendance of the students is taken by every institute, the findings were presented below.

A. Findings

The attendance report of the students is needed by every educational Institute. Many times to save the time it is required to callout the Roll
number and mark the attendance of the students, the faculties circulate the attendance sheet to the students where the students sign or mark their attendance. But it was observed that when it’s marked in this way, there are chances of dummy attendance or the attendance sheet can be misplaced and copying this attendance in the attendance muster becomes an additional task for the faculties. In two Institutes out of 18, RFID was used for the attendance of the students. The attendance taken by these institutes is in different manner. These are described below.

First Method of Implementation:

Reader: Short range (@10 cm), fixed

Tag: RFID card with every student

In this Institute the students carrying RFID cards punch the card to the reader fixed on the door frame of the classroom and then enter the class. This type of reader was used in the Institute in the year 2006-07 and was used for a year, but the reader was not that robust and got damaged by the mischievous students of the Institute. One major problem faced by the institute that time was, the students sometimes used to carry more than one card and used to mark the attendance of their friend and to check number of students were actually present was difficult and time consuming.
Second Method of Implementation:

**Reader:** Short range (about 10 cm), mobile with a display for User Interface

**Tag:** RFID card with every student

Taking into consideration the problems of fixed reader, in the other Institute where the RFID implementation experimentation was done, the students’ attendance was being taken in slightly different manner. The solution was proved to be cost effective and very easy to implement. The solution is as follows:

Instead of a mounted, fixed reader, a handheld or mobile reader is being used with a screen displaying the number of students present in the class. This reader was then passed to every student with the RFID card, when the reader is being held by the student to pass it on to the next student, the attendance would be marked automatically by the reader. After passing it through the whole class, it’s received by the teaching faculty again. The faculty could then check the number of students displayed on the reader screen with that of the head count to cross check the attendance.

### B. Conclusions

All the educational institutions are concerned about student’s irregular attendance, absenteeism. Absenteeism can affect student’s overall academic performance. It is thus required for educational Institutes to have ready-to-use solutions that simplify and increase the speed of data collection and increase the lecture efficiency.
To address these problems, RFID-based system is a solution which could automatically record the incoming and outgoing timings of the students not only in Class rooms for lectures but also in laboratories as well in library reading rooms.

After the above findings from the RFID implementations, it can be concluded that, the first implementation method which was proved to be unsuccessful because of following reasons:

i) The reader being fixed so there was a possibility that the reader may get damaged.

ii) Possibility of dummy attendance by the students because of the mounted reader without any display.

iii) It was required that wherever the attendance of the students needs to be taken, there have to be a fixed reader, thus increasing the number of readers and thus the cost of implementation.

The second implementation method was proved to be successful because

i) It was possible to control the dummy attendance.

ii) It can also be cost effective since there is no need to have number of readers for each and every classroom. Once the attendance of one class is over it can be handed over to other class, in case if the Institute does not want to invest more in readers.

Through this observation it can be concluded that,
i) The best way to take the students attendance in the class is through a movable reader which displays the numbers of cards read. If the students are disciplined, and the long range reader is used, the students just can pass the reader and still can get detected.

ii) One more conclusion which can be drawn that this kind on attendance with the help of RFID will able to tell the information not only about the students attending the lecture but also about whether the lecture started in time, according to the time table and at what time the faculty entered in the class. This is possible if the faculty marks his/her attendance first and then starts marking the attendance of the students immediately. This will tell the Director whether the lectures are going on as per the schedule, with number of students attending the lecture.

iii) Once the correct data is with the institute or faculty, the defaulter list can be prepared, letters/SMS can be sent to the parents about their ward’s attendance,

iv) If everything is connected through network. It is possible for the Director or the concerned head to check the details real time anywhere on the Globe.

v) The attendance in the laboratory also can be checked in similar way. But since the students also sit in the lab like computer lab other than their Practical time, a fixed reader need to be mounted on the entry door of the lab.
The RFID equipment details for students' attendance in class room and computer laboratory are given in the section 6.0 under the framework model

II. Students’ attendance in library reading room

A. Findings
For many purposes, the data related to the students' attendance in the library reading room is required. The attendance taken in this way, tells how many times and how much time students visit the library thus telling the reading habit of the students. Due to the above mentioned points it is seen that the libraries of all the institutes (100%) maintain students attendance by keeping an attendance register in the reading room. But it is also found that it becomes very difficult to maintain it since the students entering the reading room are not keen in entering their name in the register and it is not possible for the librarian or any other staff to keep a watch on them.

B. Conclusion
Since attendance of the students is required in the reading room, and it would be difficult to mark attendance with mobile or hand held RFID reader as is done in class room attendance. For library reading room, a fixed reader would be more appropriate since there is no fixed time for the students to come in the reading room. A fixed reader mounted on the reading room door frame, will record the students attendance. If the reader used is long range reader it can track the students at a large distance.
The RFID equipment details for students’ attendance in reading room are given in the section 6.5 under the framework model.

III. Students’ attendance in mess
As the students’ attendance in classroom, laboratories, reading room is necessary so is it necessary in the mess. The reason is, there are institutes which are accepting the mess charges from the students at the time of admission and pay the mess charges to the mess contractors on behalf of the students.

A. Findings
In all 16.67% institutes pay the mess contractors on behalf of the students, meaning they take the mess charges from the students and pay the contractors on monthly basis. (Reference: Table No.4.3.6). The payment is done on the basis of number of students irrespective of whether they had their lunch or dinner from the mess or not. Only 5.56% institutes pay the contractor depending on the actual number of students having food in the mess. They do it with the help of RFID.

A very effective use of RFID is observed in one of the institute where it is used in the mess for student attendance. The institute belongs to an organization which has a large campus running the professional courses like Engineering, Medical, and Management. The campus has hostels for boys and girls, total 5 mess for the hostel students. The institute is taking the mess (lunch and dinner) fees from the hostel students at the time of admission. The institute then pays the
charges on behalf of the students to the mess contractor at the end of every month.

The researcher interviewed the Estate manager and the mess contractors for understanding the exact working of the mess billing system which is as follows:

Initially the Institute was paying the contractor not according to the number of students who actually had food for the month, but still used to pay the bill according to the number of students who had paid mess fees at the time of admission without checking whether they actually had the food or not.

After working in this way for some period it was observed that about 60% of the students opted for mess are not taking the food. But still the bill is paid without calculating the number of students.

A solution was found out and then. A finger prints scanner was kept on the counter of the mess. The students were asked to make use of the finger print scanner to mark their attendance in the mess when they want to have their lunch or dinner. The bill used be paid as per the attendance given by the students i.e paid at actual.

After few months, the mess contractor complained that the students were not using the finger print scanner and the problem was the time required for scanning the finger print. Sometimes the scanner used to not scan for the first time and the students had to keep on trying, in which students were wasting their time in the lunch break. So the students were not ready to scan the finger print and thus the numbers
of students present were shown less by the scanner, which was not acceptable by the mess contractor since the bill was being paid to him according to the scanner reading.

A better solution found was the use of RFID. RFID reader was then kept on the mess manager’s counter and each student was given a RFID card, for marking the attendance instantly when they come to mess for lunch or dinner.

This solution, gave the actual number of students and thus saving the institute’s large amount of funds per month since the bill amount is reduced to half. Moreover the time for bill calculation was also saved which used to take about 10 days earlier after the end of the month, now it was possible in just one day.

The RFID equipment details for students’ attendance in mess are given in the section 6.0 under the framework model

**B. Conclusion**

From the above findings it can be concluded that when the Institute has hostel and mess and when the fees for the same is collected at the time of admission, use of RFID is a better option to take attendance of the students and pay the mess contractors only at actual.

This system would be beneficial especially to those institutes which have their own hostel and mess and the mess is run by the contractors.
If the RFID card is given to the students then, the student’s related data about the fees, mess charges, book details, percentage of attendance etc. on real time basis without opening any related document of the student is possible when the student passes the reader. This online information will be useful to increase the efficiency of the related work.

IV. Staff attendance

Every organization needs to maintain the attendance of the employees for the proper discipl. The following are the findings and conclusions drawn by the researcher related to the staff attendance.

A. Findings

As is observed from the collected data from various Institutes, the teaching staff have varied incoming and outgoing timings and these timings keep on changing from semester to semester. Due to this the office in charge face lots of problems related to late marks. Moreover calculating or deducting the pay due to late coming also becomes a problem and is creating unhappiness amongst the office staff and other staff.

In 11.11% institute RFID is implemented for staff attendance, it has become very much useful for both non-teaching and teaching staff. According to the office-in-charge nobody now argues on the timings recorded by the reader.
It was also observed that, in 11.11% institutes finger print recognition device is being used for staff attendance. There it is observed that when maximum staff have the same incoming time, due to this, at times the crowd increases at the scanner and then becomes difficult to mark the attendance in time. Sometimes the finger print scanner do not detect the image properly in the first go and then it consumes a lot of time.

**B. Conclusion**

From the above findings, it can be concluded that use of RFID in staff attendance would be beneficial not only to mark the correct attendance but will also save the office in charge’s time for calculating the monthly payment of the staff.

Apart from this, there is one more advantage of using RFID especially for teaching staff. It is observed that many times the faculties need to re-schedule their lectures, sometimes it may be due to unavoidable reasons. Many times the Director is not aware about this. The problem can be solved by using RFID by giving a dashboard which will display the details to the Director/ HOD as mentioned in section 6.6.

**Drawback:** There is one problem raised by one of the responder. There is a possibility of wrong practices due to the use of card. If any faculty gives her/his card to some other faculty and marks the attendance then how it can be controlled?
In such conditions, the researcher feel, it’s a question of attitude of the person, even if RFID is not used, a similar problem may be faced.

Thus it can be finally concluded that use of RFID for staff attendance is perfect solution for all the problems discussed above in the findings.

The RFID equipment details for staff attendance are given in the section 6.6 under the framework model

V. Report Generation

For any institute or organization, preparing the data reports is very important. In case of preparing the report especially in educational institutes, the collection of data takes too much time and still no one is ready to give 100% guarantee of the correctness of the data. The researcher asked question to all the respondents with respect to the time they spend in for preparing the reports. The finding and conclusions are as follows.

A. Findings

It is observed in the Institutes, that the reports like students subject wise attendance in class room, computer lab, internal marks, defaulters list, assets details, date wise book details, library reading room attendance of the students are not ready with the Institute. The staff starts preparing whenever the reports are required. Actually if these reports are prepared timely (online), they are helpful for many
processes. Thus it's always better to prepare the data as soon as the process is completed.

But as discussed in the students attendance (Refer: Point I from this section) there are manual ways of taking students attendance in class but the reports are not done immediately, there is also a possibility of misplacement of the sheet on which the students attendance is taken, in laboratories & reading room. Even if the attendance registers are kept, the students are unwilling to enter their name in the register. Thus the data collected in this manner may not be 100% correct.

B. Conclusion

The data accuracy advantages are inherent in all types of automatic identification technology. Additionally, RFID does not require any human intervention, is non-line of sight technology. RFID is a technology that may possess both read and write options within the same equipment item and as compared to finger print scanning it work fast with simultaneous reads.

If the collection of data like attendance of the staff, students attendance in computer lab, class room, library reading room is taken by the reader, the records related to attendance would be made faster and accurate than before. The processing to be done on the collected data can be done faster for eg. making defaulter students list, sending letters/SMS to their parents, Internal mark generation would also become fast since the attendance marks can be reflected
automatically. For all these process an application software need to be developed or purchased.

VI. Asset checking

Checking and keeping track of asset and their location is very much required for any institute, since the computers, projectors, laptops are easily moved from one place to other. Keeping this in mind, the questions were asked to the respondents. The findings and conclusions are given below.

A. Finding

As discussed earlier there are 94.45% institutes which run more than one course in the same institute. Every course has it's separate requirement of the equipment. The asset and equipment details, dead stock registers are required to be maintained by every institute course wise. Since the institute runs more than one course, when the asset details are need to be checked, it becomes very difficult to understand which equipment belongs to which course.

It was also noticed that 81.82% institutes do the asset checking in computer lab (Reference: Table 4.6.1) only 23.07% institutes do asset checking more than once in year (Reference: Table 4.6.5)

Total 72.22% of the institutes do the asset checking of the other equipments in the institute (Reference: Table 4.6.4)
When asked about the opinion about increasing the asset checking frequency 83.33% institutes are of the opinion that the asset checking frequency should be increased. (Reference: Table 4.6.6)

**B. Conclusion**

The institutes have understood the importance of asset checking not only to keep the updated record of the assets but also for the security purpose. So the institutes are interested in increasing the asset checking frequency, but due to time constraint it is not possible. This problem can be very well solved if RFID is used in asset checking and monitoring. A new level of efficiency can be achieved by using RFID which will help in auto generated asset reports with location. If any asset need to be traced, it is also possible online.

It also should be noted that now most of the people own laptop. In such a situation even in presence of a security guard, it is very difficult to understand if someone lifts the institute equipment. This is possible to control with the help of RFID.

For tracking the asset for security, the system is similar to that of a shopping mall. The RFID tag would be placed on the equipment. A reader would be a fixed reader with antenna placed on the key positions like entry or exit points of the institute like main doors.

Even if RFID is useful in this kind on application in places like shopping malls, this may not be successful in the educational institute since there may not be only one entry or exit, there are many window openings, which the shopping malls do not have due to centralized Air
conditioning, through these doors or windows, it is possible for anyone to lift any of the Institute’s equipments, out of the Institute in spite of the RFID security.

Also there is very less control on the visitors coming to the institute, since enquiries are throughout the year. In addition, if someone is aware of the kind of security system, it would be easier to remove the tag. This kind of system is possible to use in shopping mall since, along with the RFID system there are Close Circuit Cameras to keep a check on the customers.

Keeping these points in mind the Researcher has limited the use of RFID In asset checking for stock checking purpose only. The RFID equipment details for asset checking are given in the section 6.0 under the framework model

VII. Monitoring the maintenance contract visits

The institute has equipment which need to be maintained. Many times annual maintenance contract is given by the institutes for the equipments. But as the number of equipment increases it becomes difficult to monitor whether the service engineer is visiting the institute as per the schedule. To understand the opinion about the monitoring, the researcher interviewed the stakeholders like system administrators and office staff. The finding and conclusions are given below.

A. Finding

While collecting the data about maintenance contract of the
computers it was found that only 27.78% institutes have Given Annual Maintenance Contract for the computers and laboratory hardware. When interviewed them it was understood that they find it difficult to monitor the visits of the service engineer.

When the office-in-charge was interviewed, it was noticed that all the institutes have water filter and the water cooler, which is under Annual maintenance contract and it becomes really very difficult to monitor the visits of the engineers as per the schedule.

B. Conclusions

Since the data collected was from MCA institutes, the system administrators, engineers were present in the campus throughout the day so it becomes possible for them to find the fault and maintain the equipment. But this may not be the case with other professional institutes.

Since maintenance visit monitoring is difficult for the equipment under contract, RFID is a good solution for tracking the maintenance status. Through RFID it would be possible to check the service engineer’s visits and visit timings, the details of which would be recorded by the reader when he visits or maintains the machines. This data will help the management to take decision whether to renew the contract with the same agency or not.

The RFID equipment details are given in section 6.0 under the Framework model.
VIII. Guard patrolling

Every Organization need a security guard for the security of the assets of the organization. But it is very difficult to check whether the guard is doing his duty as told to him, whether the guard is a contract labor or is the employee of the institute, a monitoring is required. Keeping this in mind the researcher asked the question about the guard monitoring to the stakeholders. Following are finding and conclusions.

A. Findings

It was seen that even if there is security guard at the gate, the movable assets like TFT monitors, laptops, mouse, projectors were inside the building which are very easy to lift. So some kind of security is also needed inside the Institute building. As given in the conclusion in the section VI Asset Checking, it would be difficult to increase the security of the assets by tagging the assets.

Also it was observed that in most of the institutes, the lectures start either early in the morning or get over by late in the evening, the teaching staff had distributed the timings, due to which the lectures go on in the institute even after the office is closed.

It was also observed that there were guards for security at every institute, along with a supervisor to keep a check on the guards. But there was no proof observed as such whether the duty is really done perfectly. Where the number of guards were more due to the large campus size, it was difficult to check whether the guards have taken rounds in the campus as assigned to them. At night it becomes really difficult to keep a watch on their work according to the respondents.
The researcher noticed that only 1 institute out of 18 institutes (5.56%) have found a solution on this issue partly (Reference: Table 4.7.1). The institute has a bell which is fitted in the campus and rings after every 1 hour, it useful especially to keep the guard awake at night, but the monitoring of his working is still could not done.

The RFID equipment details are given in section 6.0 under the Framework model.

B. Conclusions

To monitor the working of the security guard is really necessary for the institute. Installing CCTV camera may be a solution. But installing the cameras outside the institute in open air would require cameras which are waterproof which are costly and the number would increase depending on the campus area or number of routes for the guard.

RFID is a better solution for this issue. Here RFID tag would be placed on the required route where there are movable equipments. The route can be designed by the institute authority in such a way that the guard will have to visit the place, may be inside or outside the building after specified time. The security guard with the handheld mobile reader would wipe it against the tag, the reader would then record the timing and the tag number. Whenever the data from the reader would be downloaded, the details of the guard patrolling could be found out.
IX. Library

Library is one of the very important place as far as any professional, educational Institute is concerned, The efficiency of various processes which are the part of the working of the library should therefore be considered when thinking about the working effectiveness of the institute as a whole.

A. Findings

For any library, 3 processes need to be considered apart from the attendance of the students in the library reading room. Which is already discussed in the section I. Students’ Attendance. The processes are: Stock checking of books, Issue return of books and Security of books.

Stock checking: With reference to data presented in table no. 4.8.5 & 4.8.6, it is observed that the stock checking of libraries is time consuming which takes from 5 days to 1 month depending on the number of books in the library, as per the data collected from various libraries. Apart from the time required, the stock checking requires man power which vary from 2 to 9 and for this reason libraries do the stock checking only once a year but it was found that 75% respondents feel that the stock checking frequency should be increased.

Book issue & Return: Every library generally has some peak hours when maximum number of students come to the library for the issue and return of the books. It was observed that 44.45% libraries are
bar coded, in these libraries even at peak hours, the librarian do not face any problems while issuing or returning the books, so these institutes do not feel the need of using RFID to increase issue return efficiency.

*Book Security:* On security front, only 38.89% librarians feel that the securities of the books need to be increased.

Students as well as staff both use the library, so a question was asked, whether RFID should be used in library. 83.33% respondents felt that there is a need of it. (Reference: Table 4.8.13)

**B. Conclusion**

Issue Return process: It has been understood after talking to all the Directors and Librarians that RFID for issuing and returning of books would be useful, but when the libraries are having bar coded books, RFID may not be needed, since the issue return efficiency is already increased due to bar coded books.

Stock Checking: The time and man power required by the stock checking of the books is very high. The process which is followed in the library is as follows:

The books are removed from the shelf, then are checked with the bar code reader and then are kept back on the original shelf which consumes lot of time and energy of the person. Here RFID implementation would be effective since if a mobile reader is used
and if the books are tagged with RFID tag, there would not be any need to remove the book from the shelf.

Security: When it comes to security, according to most of the respondents, the cost of the books is in a range of Rs. 100-1000 hardly there are book which cost more than Rs.1000 and it is also understood that the average number of books lost per year is not more than 15, which are more due to students not returning the books. In addition to this these books are available in the market, sometimes only older edition are not available, but latest editions are present in market. In addition to this, if one compares the cost of lost books and the RFID equipment needed for implementation, the RFID implementation cost would be far more that the number of books which are lost in a year. Thus at present implementing RFID at institute library for security purpose may not be cost effective. But as the costs decrease, the implementation would surely be beneficial.

Thus it can be concluded that RFID is useful for the stock checking where bar code is not of much help comparatively, but at present implementing it may not be cost effective. So as far as RFID implementation in library is considered, it is more useful in reading room attendance.

If the value of Spearman’s Rank Correlation coefficient (rho) for Effective working of the institute and implementation of RFID in library, gives the value as 0.204 Which is the lowest amongst all the implementation areas discussed up till now. The above description gives the reason for this weak correlation.
6.3.3 RFID Technology related findings

A. Findings

When questions were asked to every faculty/respondents about their knowledge about RFID technology, it was found that 73.12% of the respondents are aware about the technology. (Reference: Table 4.10.1)

B. Conclusion

The stakeholders of the Institute are well aware about Automatic Identification technologies as well as about RFID. Thus there would not be any difficulty in implementing the technology.

Thus it can be concluded that Implementing RFID in the various areas as given above would help to increase the effectiveness of the day to day working of the Institute. Due to this the staff could use their time productively.

6.4 FUNCTIONAL DECOMPOSITION FOR RFID IMPLEMENTATION IN A PROFESSIONAL INSTITUTE

Even if the data collected by the researcher is only from MCA institutes affiliated to University of Pune and recognized by AICTE, New Delhi, the researcher is of the opinion that the framework model developed will also be helpful to all the professional institutes running courses other than MCA.
The above Figure 6.4.1 shows the six constituent functions which are common and are present in all the professional institutes are considered for the implementation. These functions are shown in the functional decomposition approach just to specify that every function is in turn can have sub functions which are related to that function. This does not mean that if any function is decomposed into three function then all these three functions need to be implemented, but if are implemented will be cost effective since the RFID equipment will not be required to be purchased again for that function.

Same is the case with other constituent functions, it is up to the individual institute, to decide where the automation is required.

This is why the above diagram should not be considered as layered diagram and hence considered in the framework model.
The figure includes the six constituent functions namely Staff attendance, Report generation, Student attendance, Asset checking, Guard patrolling and Library. From these, at the Top Report generation is shown since the report generation is required for every function so it is a part of every function shown below it.

Phase wise implementation which should be done and places where the reader and RFID tag / card should be used. The readers can be interchangeably used for other functionalities.

The diagram shows the first function as staff attendance and last function as library where the RFID cards for staff and students can be used which have been purchased for the functionalities implemented earlier.

The framework model given below give the order of implementation which is given by the number and the adjacent text on the arrow shows the required hardware or software for the implementation. The RFID reader and RFID tags may vary as per the requirement, availability and the need of the Institute. According to the researcher the implementation should be done phase wise as given in the figure 6.5.1 below with the number. Once the first implementation starts giving results as per the requirement of the stakeholders of the institute, then the next implementation should start. The implementation in the earlier phase will give many key observations which are specific to the institute which can vary from institute to institute such as the position where the fixed reader should be fitted, whether any HR policies need to be modified, when the reader is mobile where should it be kept, who would be the in-charge of it so on and so forth. Few such points are
mentioned in the section ahead which will describe each phase in detail.

If any Institute want to implement first functionality and directly want to implement the last functionality instead of following the phase wise implementation order given, the reader or tag details need to be added as per the requirement of that functionality.

6.5 FRAMEWORK MODEL FOR RFID IMPLEMENTATION IN PROFESSIONAL INSTITUTES

The following figure 6.5.1 gives the suggested model for RFID implementation in a professional Institute. The numbers given below for the constituent functions tell the order of implementation of RFID in the Institute, though it is not mandatory to follow that order while implementing. The hardware and implementation details are given in the recommendation section in the figure 6.6.1
1. REPORT GENERATION
Software module for data gathering from readers and formatting

2. Staff Attendance
- Fixed reader in the office
- RFID card for each staff

3. Students' Attendance
- Fixed /Mobile reader in class
- RFID card for each student
- Fixed reader in laboratories
- Fixed reader in Reading Room
- Fixed reader in Mess **

4. Monitoring Guard Patrolling
- Tags for each keypoint in guard route
- Mobile reader for each guard working in same shift

5. Asset checking
- Tag for each Asset
- One Mobile reader

6. Library
- Tag for each book
- Mobile reader for stock checking
- Fixed reader for book issue return
- Fixed gate reader for security

** Where mess attendance is needed

Correlation Coefficient 0.412
Correlation Coefficient 0.301
Correlation Coefficient 0.323
Correlation Coefficient 0.361
Correlation Coefficient 0.688
Correlation Coefficient 0.204

Figure 6.5.1 Framework model for RFID implementation in Professional Institute showing Spearman's Rank Correlation Coefficient (Rho) for working effectiveness of individual function
RFID implementation in constituent functions to increase Institute’s working effectiveness

<table>
<thead>
<tr>
<th>Constituent Functions</th>
<th>Spearman’s Rank Correlation Coefficient (Rho)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library</td>
<td>0.204</td>
</tr>
<tr>
<td>Asset Checking</td>
<td>0.688</td>
</tr>
<tr>
<td>Monitoring Guard patrolling</td>
<td>0.361</td>
</tr>
<tr>
<td>Student’s Attendance</td>
<td>0.323</td>
</tr>
<tr>
<td>Staff Attendance</td>
<td>0.301</td>
</tr>
<tr>
<td>Report Generation</td>
<td>0.412</td>
</tr>
</tbody>
</table>

Chart 6.5.1 Bar chart showing the value of Spearman’s rank Correlation Coefficient for various functions

The description of each implementation phase along with the hardware requirement and implementation issues which need to be considered are described in the following section.
* Identify person or object to be tagged.
* Select the type of tag as per the application (Read range, EPC/ISO standard).
* Select Vendor giving required support.
* Calculate number of required tags.

- Select the type of Reader compatible to the tag (read range, handheld or fixed, antenna, middleware details and available API)
- Select the vendor who can give both hardware and software(if required) support
- Verify the tag and reader
- Calculate the number of readers to be purchased (depending on the key positions)
- Attach the tag to the object and verify the working with the reader.
- Install the fixed readers at the locations decided

**MIDDLEWARE & API**
With required algorithms/protocols
- Check the Middleware with provided and required algorithms
- Check for any specific Operating System requirement

**APPLICATION SOFTWARE & DATABASE**
- Encode the tag.
- Use the tag number in the application intended. A ready-made software also can be purchased
- Integrate the RFID information into the business flow.
- Integrate all the applications implemented phase wise.

Application wise Real time Report to stakeholders

**STAKEHOLDERS**
Director, Teaching staff, Office-in-charge, System Administrator, Librarian

*Figure 6.5.2 Stepwise approach for RFID Implementation*
(i) IMPLEMENTATION PHASE 1: REPORT GENERATION

Report generation phase gives the output of every phase in report format either online or offline. Any phase to be implemented, the respective appropriate reports required to be generated. Thus in the figure 6.5.1, it can be seen that the first phase is shown as Report Generation which accepts the information coming from various readers used for various functions processes it and displays the online or offline report as per the requirement in correct format.

This phase is continuous along with every implementation phase, since software need to be purchased or developed according to the requirement. If the software is to be developed while purchasing the readers it is necessary to understand the software Application Interface, the middleware which comes along with the reader. It should also be checked the Operating system requirements of the reader, since there are many readers available in the market which work on open source like Linux.

The report generation phase is thus a part of all the phases which does the work of integration of all the implementation phases.

(ii) IMPLEMENTATION PHASE 2: STAFF ATTENDANCE

Whenever any new technology is to be implemented, people need time to get acquainted with it. Thus if initially the staff uses it for the attendance purpose, the further implementation in other functionalities
would be smooth and easier. In addition, if one looks at the financial part of the implementation, the RFID equipment required for the implementation is not very expensive. So according to the researcher the implement the technology can from the staff attendance.

**A. Hardware Requirement:**

1. RFID passive, read-only card with minimum range 3-6 inches. The number of cards required would depend on the staff in the institute as well as any guest lecturers coming to institutes.

2. RFID Reader with minimum range 3-6 inches. The reader should preferably be a fixed reader. There are some readers available which have facility to scan finger print along with RFID. This would be added advantage, but cost would increase.

3. Need to be checked the whether the Application Interface is given along with reader .

**B. Place of installation of the Reader:**

1. Better to install the fixed reader on office wall at a height accessible to any staff and where it would be easy to punch the card.

2. The place where the reader would be installed should be accessible whenever anyone wants to punch the card even after office hours. Say in holidays when the extra lecture is to be held or any guest lecture is to be held.
C. Related issues which need to be taken care of:

1. If the RFID Reader unit does not have finger print scanning then the HR policies should be set in advance for the cases when staff comes without the card.

2. Every staff should be made aware that while entering and leaving the institute card has to be punched by the person who owns it.

3. The cards given to guest lecturers can be taken back at the end of the last session of the subject and can be used for the other for the next semester. Thus this system will work as a closed loop system.

4. Policies in case of loss of card should be framed.

(iii) IMPLEMENTATION PHASE 3: STUDENTS’ ATTENDANCE

Once the staff becomes familiar with the technology, then in the next phase it can be implemented for students

A. Hardware Requirement:

1. RFID passive card (passive without memory preferably having EPC number) with minimum range 6 inches. The number of cards will depend on the number of students in the institutes. The cards given to the students can be taken back at the completion of the course and can be used for the other students for the next semester.

2. RFID Reader with minimum read range 3-6 inches. As mentioned in staff attendance, there are readers available which have facility to scan finger print along with RFID but they would not be ideal for students’ attendance, since will take time to scan, so readers with only RFID are preferred. The readers can be mobile or fixed.
depending on the location where the attendance of the students need to be taken.

3. While purchasing the reader, it is very much essential to check that how many tags the reader can read perfectly at a time. This will give the implementer the correct understanding of the way the students should mark the attendance.

I. Class room attendance:

i. Class room attendance can be taken using hand held or mobile reader with read range 3-6 inches. The mobile reader can be carried by the teaching faculty while taking a round in the class when the reader would be scan the RFID card and mark the attendance of the students. To cross check the head count of the students can be taken to check the number shown in the reader to avoid dummy attendance. Here the reader having a display would be the most appropriate one.

ii. There is one more way to mark the attendance of the students with mobile reader where the students themselves can pass on the reader when the attendance of the students can be marked. Once the attendance of all rows of the students is over the reader can be given back to the teaching faculty who can cross check the reader display with the students head count.

iii. To understand the faculty details the reader should mark the faculty card first and then start marking the attendance whether the reader is fixed or mobile. This will give the time of
start of the lecture as well as the faculty who is conducting the lecture in that class.

For students’ attendance, a mobile reader option is better since in case of a fixed reader, one reader per class would be required thus increasing the number of readers as against the mobile reader, the same reader can be used for taking attendance in any class rooms.

II. Computer Lab Attendance
For Computer lab attendance fixed reader should be installed at the entry door of the computer lab since the students can come and use the lab anytime in the institute working hours, when the lab assistant may be doing some other work and may not be present in the lab in some cases. The reader would note the incoming and outgoing time for every student.

III. Reading Room Attendance
For library reading room the reader should be fixed reader mounted on the reading room door with minimum read range 3-6 inches. Whenever the students enter the reading room, the attendance would be marked. There is no need to have a display for the reader.

IV. Office related information
If the students RFID I-card can be used like a multi-feature card, giving the fee, pending documents and other educational details, it will reduce the administrative work.
When the student enters the office, the reader kept in the office (used for the staff attendance) will read the card id and his information can be displayed which will be useful for administrative work.

While purchasing the reader, it should be checked whether the Application Interface (API) along with the software module, is given along with the reader. If the software is not purchased and need to be developed in-house then the API should be studied properly so that the data from the reader can be used in correct format as per the requirement.

B. Related Issues which need to be taken care of:

1. It should be made compulsory for every student to possess a card when he/she enters the Institute campus.
2. When the head count of the students present in class is less than that of the display count of the reader, there has to be dummy attendance given by some students. Which need to be checked randomly at the initial stages of implementation to control such incidences.
3. If the Institute wants to use the same cards given to the students again for the next batch, then the students should informed to submit their card to the Institute. The same cards can be then used for next batch of students by associating the information of the new entrants.
4. While purchasing the reader, the location of the other readers need to be checked, because if the read range of more than two readers collide, the effect may not be desirable, the data read may not be correct. In such cases the reader with anti collision module present in the middleware should be preferred.

5. When the reader is fixed and many students come in the read range of the reader simultaneously, then the readers may not read the data correctly and unable to give proper read results. In such cases readers should have singulation procedure to singulate the tag read.

(iv) IMPLEMENTATION PHASE4 : MONITORING GUARD PATROLLING

The security of the assets of the Institute can be achieved by a combination of RFID technology and manual monitoring.

A. Hardware Requirement:
A mobile reader with built-in antenna, having memory with read range not more than 3 inches.
Tags which can withstand the external environment like the heat, water. The number of tags would depend on the campus size, number of key positions where the guard needs to punch the tag and the number of such routes.
The number of readers depends on the number of security guards on duty in the same shift.
B. Placement of the tag
In this application, the tags would be fixed on the key positions where the management wants the guard to take a round when he is on the duty. The time for the round also can be informed to the guard. The guard need to swap the reader against the tag placed in the route. The data can be downloaded from the reader next day or as per the schedule to check whether the guard is taking the rounds as per the timings.

C. Issues need to be considered
The setting of the route should be done properly. The routes can be inside the building or outside. The timing for the route visit should be changed randomly for the security reasons.

(v) IMPLEMENTATION STEP 5: ASSET CHECKING
If one compares the cost for the RFID equipment required for asset checking it is comparatively costly as compared to that required for students, staff attendance. So the researcher feels, once the Institute’s RFID implementation system becomes matured, asset checking can be implemented on the fifth place.

A. Hardware Requirement
1. In case of asset stock checking, the hand held reader with memory is recommended. Since for asset checking the each asset may not be movable or even if it is not fixed it would be difficult to bring it to the reader. Thus hand held or Mobile reader would be the correct option.
2. Each movable asset would need the tag which is not similar to the student or staff RFID card. It should be possible to paste the tag on the asset which may be metallic. Pasting the tag in proper position is also important, so that the tag does not get damaged. If any tag is to be put on any of the fixed asset which is placed outside, which may be exposed to the heat or rain water, thus in such a case the tag which is heat proof and water proof should be used on the tag.

3. If the position of the asset is also should be recorded i.e for asset tracking, the tag also can be put on that location eg. if computers are tagged, then a tag also can be pasted on the computer lab door frame somewhere from where it would not be possible to remove it easily. This will help the person who is doing the asset checking of the movable asset to record the location of the asset while stock checking. If while checking the asset before entering the location (say Computer lab) the person would first get the data from the tag which is pasted on the location, so that while asset checking, the position of the asset along with the asset identification will be gathered.

4. In case of tracking the movable asset, the readers would be fixed on key point like entry and exit gates. The tag on the asset and the RFID card with the student does not show permanent association (ownership) then it can be concluded that the asset is being carried by someone other than the owner. The reader can give this output to some buzzer or light, which will give the danger signal. This
working is similar to, when the students takes the books from the library shelf without getting it issued from the librarian.

C. Related Issues which need to be taken care of:

When pasting the tag for the asset, the place where the tag is to be pasted is very much important as well as to know the Dielectric constant of the material on which it would be pasted, since materials like paper, plastic, glass with low dielectric constant are supporter of electrostatic field.

(vi) IMPLEMENTATION SUBJECT STEP 6: LIBRARY

The final step in the implementation framework model is given as library. When one compares RFID with the bar code technology even if there are lot many advantages of RFID over bar coding, the cost is a major factor where the bar coding wins over RFID.

A. Hardware Requirement:

1. For library application the tag should be like a sticker which can be pasted on the book. This tag should have a SET / RESET bit which tells whether the book is issued by the librarian or an authorized person in the library by marking the entry.

2. For issuing and returning of the books there are two options:
   a. A desktop reader can be placed on the counter which can detect the tagged book returned or issued.
   b. A dropdown box can be used to drop the book which is to be returned, from which the books can be collected latter.

3. For stock checking of the books, a mobile reader should be used so that there is no need to take the books out of the cupboards.
4. For library reading room attendance, the requirement and the discussion is already done in section 6.1. I. Students’ attendance.

B. Placement of the reader & tag
The placement of the tag is very important, first of all it should be stuck on any random page. It should be placed in such a way that when the book is kept in the shelf it should not be far away from the edge of the bookrack else it may give reading problem. This problem was faced at the Jaykar Library of Pune University, where in the initially the RFID tag was pasted on the centre of the page, so while taking the stock it used to give the reading problem. When the tag location was changed the problem was solved.

C. Related Issues need to be taken care of
There is a possibility of tearing the book pages where the tag is pasted. For this students need to be trained.
If drop down box is used for returning the books, there is possibility of books getting damaged, so as far as possible using a desktop reader is better option for both issuing and returning books, where it also saves cost of another reader for returning of the book.
Placing the tag properly inside the book is important else it may not get read tracked properly.

6.6 ADDING BUSINESS INTELLIGENCE TO THE INSTITUTE

With the implementation done in this manner a Real time Dashboard can be displayed which will give the details online which will include the
real time information on:

i. Staff present / absent
ii. Who is teaching in the class or no lecture is going on in the class.
iii. Students attendance in class
iv. Number of Library book volumes and titles available in the library
v. The computers, projectors

This dashboard can be a dedicated computer displaying the real time information of the institute by accessing the central server on which the data from all the readers would be stored. This can be fixed in the Director’s / HOD’s cabin seeing which he/she will get the updated information and status without even a press of a button, thus giving the Institute an edge of Business Intelligence.

The figure 6.5.3 gives a possible format in which the dashboard will display the information.
Depending on the RFID implementation in various functionalities, the information would be displayed on the dashboard.

### 6.7 RECOMMENDATIONS

For any function where RFID is to be implemented, the type of tag suggested by the researcher should preferably be recognized by EPC global or ISO standards, since to a large extent, choosing a tag is choosing the type of RFID system one intend to build. This is so because the migration from one reader to other would be easier if the reader is to be changed at a latter stage of implementation, also with the upcoming technologies the upward compatibility of the tags is generally
maintained. Some vendors sell unique IDs, but these are unique only to that specific vendor, they are not globally unique as in ISO or EPC.

6.8 RECOMMENDATIONS IN OTHER APPLICATIONS IN OTHER EDUCATIONAL INSTITUTES

After studying the various applications in professional Institutes, there are some recommendations given by the researcher on how the technology could be helpful in some more areas in any Academic Institution.

1. The participants of various conferences can be given the tagged cards which could link the information of the participant, so whenever the participants need to be contacted as per their details, it can be done very well, if any of the participant need to be tracked, it can be done easily, the snacks, lunch, dinner details also can be stored against the tagged person. Thus the crowd management can be done efficiently.

2. A very useful application on this technology is in school, which will reduce the parents’ stress and tension. When a child goes to the school, it’s really a concern for the parents whether he/she has reached the school, the use of RFID will reduce this worry of the parents. As soon as the child enters the school premises, the tagged l-card data would be read by the reader and through SMS the parents could be informed that the child has reached the school same way when the child leaves the school, the reader would read the data and send the SMS to the parent.
3. Various **documents can be tracked** and the misplaced documents can be found out if the documents are tagged.

4. The incoming timing can be recorded for the **students staying in the hostel**. So there will be a proof with the rector if the students are not coming in time to the hostel.

5. To avoid duplication of **certificate** or documents the RFID is being used in many Institutes, same way it can be used in these institutes for students’ certificates.

6. The **vehicle parking** for bigger campuses can be controlled through the RFID.

7. The RFID cards can be used to **grant access to certain area** like staff room, server room, where RFID can be used along with the door lock.

Finally imagination is the limit for the use of RFID in various areas.

### 6.9 LIMITATIONS OF THE RESEARCH

There are some limitations of the research, which could be overcome in the coming future. The limitations are as follows:

1. The research considers only six constituent functions which are discussed earlier in this research namely: Report generation, Staff attendance, Students. The processes like monitoring the maintenance contract; Asset tracking for security, opening of closing of the door with RFID card (like security lock) is not in the scope of this research. Considering that RFID may not be used in these applications at initial stages of implementation.
2. The cost of the RFID equipment and related software is not mentioned since the technology is evolving and the cost will keep on reducing. When the research was started, the cost of the tags and readers is reduced drastically. Due to these reasons, the actual cost of the implementation is not given.

3. Threats: In spite of many advantage with the RFID implementation in the institutes still there is hesitation in some of the institutes in implementing the technology due to the following reasons:
   i. Natural tendency of people is to resist new ideas which are not their own.
   ii. The time needed for implementing the technology and to use it smoothly.
   iii. A general thought – “Change in the working process means risks and unforeseen challenges”
   iv. Restricted vision of people to perceive or identify the long term benefits of change.
   v. Change costs money

6.10 CONCLUSION

From the study of the six constituent functions of the various institutes, it is concluded that the implementation of RFID in these functions would affect the non-functional requirements of the institute like administrative work performance, security, manageability thus increasing the overall working effectiveness of the Institute. According to the respondents, asset checking
showed the strongest correlation with the working effectiveness. Considering the various responses from the various categories of the respondents of the institutes and the cost effectiveness of the required equipment, a model is proposed which would be beneficial to the Institute intending to implement the technology in their Institute.

6.11 REFERENCES
