Abstract—This paper investigates the highly important critical success factors (CSFs) which are essential for implementing the Enterprise Resource Planning (ERP) systems, particularly in India. A survey questionnaire was developed, and data collected from 223 manufacturing organizations in India. The study results from the Partial Least Square (PLS) indicate that there were about nine CSFs highly important out of 15 CSFs chosen. The results would be very useful because it highlights the significance of CSF for academicians and practitioners in deciding which factors contribute the implementation of ERP projects.

Keywords—ERP, CSF, India, Manufacturing Firms, PLS

I. INTRODUCTION

Being its integrated nature, the Enterprise Resource Planning (ERP) packages are implemented in firms, which yield the tangible and intangible benefits. Many researchers [1] [8] [10] [20] explored that enterprise systems’ success is a multidimensional perspective and depend on the appropriate selection of critical success factors (CSFs).

A. Characteristics of ERP Package Implementation

Ref. [6] recommends that the firm need to customize the ERP package in order to minimize the failure rates throughout the implementation process. They further suggest that the process of configuration needs to match with organizational goals. Once it is customized, then the ERP package can be used for a variety of integrating modules in the organization. One has to be very careful when customizing ERP packages as it differ from other software applications since it is more complex to modify the source code of the ERP package. ERP vendors can help to change the functionality in case of organizational requirements.

Before and after the implementation process, the business processes need to be reengineered to meet the firm’s objectives. This will lead to realigning strategic IT planning in order to sustain the reengineering business processes. This realignment may affect the firm’s policies and procedures. Furthermore, it may change the culture of the organization. This is where the firm needs to face organizational resistance, which may cause a failure in implementing ERP projects.

The firm needs to understand the ERP packages based on the functional modules (for instance, material management, production planning, etc.) which are to be carried out on a daily basis [2] [4]. This is entirely depended on the ERP vendors and ERP brand (for instance, SAP, ORACLE or RAMCO).

II. LITERATURE REVIEW ON CRITICAL SUCCESS FACTORS (CSFs)

Ref. [15] defined the CSFs as factors that are important for the management to make decisions on enterprise issues. Critical success factors (CSFs) describe the significant areas which are essential for the firm to do effective business operations to achieve its goals [7].

Many researchers [8][10][17] studied the importance of long-term management support (LTS) to augment the accomplishment rate of ERP implementation in the firms. They argue that LTS is a crucial factor and important in the execution technology management projects. ERP-adopting firms need to understand the importance of firm’s setting-up business goals and objectives (SEB) and whether it is aligned with firm’s business process and activities [15]. [20] argues the impact of tangible and intangible benefits of ERP systems with respect to small and medium-sized public sectors in India and concluded that the perceived benefits were more after the ERP project was implemented.

The cross-functional teams (CFT) encompass both outside consultants and domestic staff of the firm who can able to build up the essential technological skills to design and implement the ERP projects in the organization. ERP In-house training (EIT) is essential and supports during the implementation of technology management projects, and trainings need to be carried out through organizations’ intranet network to increase the success rate of ERP project [14]. [4] explored the importance of the business process reengineering (BPR) during the ERP implementation and found that there was a direct relation between this CSF and implementation success.
The design of appropriate ERP architecture (AEA) is important as the projects go through the full implementation cycle from the stating phase (i.e. initiation stage) to the last phase (i.e. infusion stage). A suitable IT strategic plan (STP) should be available so that preferred ERP package meets the exact requirements of a firm. There must be a suitable data analysis and conversion (DAC) system is necessary to guarantee the accurateness of the data into the ERP system and translation also mandatory from the old system to the new system.

The inter-departmental communication (IDC) and coordination (IDP) are vital and need to be strong both inwards and outwards (i.e. suppliers versus customers) of the firm so that the firm can expect success in implementing ERP projects. The project tracking (PTG) is essential and need to undergo the full ERP life cycle stages. Moreover, the project phases are expected to be visible (VPP) to all the team members and the top management so that any issues related the project is immediately solved. The project phase update (PPU) is required to update the project phases or stages during and after the ERP project implementation.

III. RESEARCH DESIGN

A. Profile of Respondents

Three academic experts and two senior industry executives in India were identified for pilot study to assess the suitability of the instrument items based on the source listed in Appendix A. The final version of the questionnaire was posted on the Blog based on their recommendations (http://erpphd.blogspot.com/). This Blog’s address had been sent to 1269 manufacturing organizations. Through the member directory email list of Charted Institute of Logistics and Transport (CILT) India, the data was collected. After numerous reminders sent, the data was received from 223 respondents (20.82%) and adopted to analyze the data.

Most of the respondents are male (70.8%), aged between 36 and 40 (34.53%) and with a master degree in computer science (94.17%). The profile comprises of technology consultants (51.57%) and senior managers (18.39%). 17.49% of the manufacturing organizations implemented the ERP systems between one year to three years, 30.49% of the firms implemented it between three to five years, and 52.2% of the firms implemented it more than five years. The findings indicate that US$200,000 (4.48%) was lost and downtime in implementing the ERP systems. Overall, close to 6% of the firms had downtime for more than a year, and 15% of the organizations had downtime about less than twelve months’ duration.

B. Research Framework, Question and Hypotheses

Hong and Kim (2002) recommend combining the critical factors of ERP implementation under the three domains namely operational, technical and project critical success factors as shown in Figure 1.

Many researchers discussed more than 26 CSFs in implementing enterprise projects across the world. In order to choose the most appropriate CSFs based on Indian manufacturing organizations, senior executives from 16 different ERP organizations were requested to rank CSFs. They were chosen based on their experience in the implementation of their ERP projects. The top 15 CSFs identified are as shown in Figure 1 [1][2].

The following research question (RQ) is based on the 15 CSFs shortlisted by [1] and [3]:

RQ: How many CSFs are important under the domain of organizational, technical and project to lead the successful implementation of ERP projects in India?

Based on operational CSFs discussed in the literature review, the following six hypotheses were formulated:

H1: LTS is important and certainly related to implementation success (IS).
H2: SEB is important and certainly related to implementation success (IS).
H3: PEB is important and certainly related to implementation success (IS).
H4: CFT is important and certainly related to implementation success (IS).
H5: EIT is critically important and certainly related to implementation success (IS).
H6: BPR is important and certainly related to implementation success (IS).

Based on technical CSFs discussed in the literature review, the following six hypotheses were formulated:

H7: AEA is important and certainly related to implementation success (IS).
H8: STP is important and certainly related to implementation success (IS).
H9: DAC is important and certainly related to implementation success (IS).
H10: EVS is important and certainly related to implementation success (IS).
Based on project CSFs discussed in the literature review, the following six hypotheses were formulated:
H11: PTG is important and certainly related to implementation success (IS).
H12: VPP is important and certainly related to implementation success (IS).
H13: PPU is important and certainly related to implementation success (IS).
H14: IDC is important and certainly related to implementation success (IS).
H15: IDP is important and certainly related to implementation success (IS).

C. Factor Analysis in CSFs

This study used Factor analysis method to indentify which factors are critically important and expected for the implementation of ERP projects. Furthermore, the factor analysis method determines the most important factors under the domains’ namely organizational, technical and project related. If the values are greater than 0.9, then it is the most important factor as suggested by [12].

Many researchers used factor analysis [4] [5] [9] [10] to examine the significance of CSFs in ERP project implementation. They argue that the selections of CSFs were also different and based on developing and developed countries. Furthermore, it is based on the type of implementing organizations. According to [14], the software package customized to a particular firm abroad experience a problem and may not be suitable to adopt because the culture of India and other countries are dissimilar and may need additional tuning of software packages, which is difficult to carry out in particular, ERP systems. Furthermore, it may be failed even before it is implemented in any organization. The same reason is cited with various authors such as [4] [7] [10].

IV. RESULTS AND DISCUSSIONS

A Partial Least Square (PLS) software is chosen to analyse the results. Table 1 presents the factor loading of CSFs in the Indian manufacturing organizations.

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor Loading</th>
<th>Hypothesis</th>
</tr>
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<tbody>
<tr>
<td>OPERATIONAL CSFs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-Term Management Support (LTS)</td>
<td>0.926**</td>
<td>H1: Supported</td>
</tr>
<tr>
<td>Setting-up ERP business goals and Objectives (SEB)</td>
<td>0.889</td>
<td>H2: not supported</td>
</tr>
<tr>
<td>Perceived ERP benefits (PEB)</td>
<td>0.788</td>
<td>H3: not supported</td>
</tr>
<tr>
<td>Cross-Functional Teams (CFT)</td>
<td>0.912**</td>
<td>H4: Supported</td>
</tr>
<tr>
<td>ERP in-house Training (EIT)</td>
<td>0.772</td>
<td>H5: not supported</td>
</tr>
<tr>
<td>Business Process Reengineering (BPR)</td>
<td>0.919**</td>
<td>H6: Supported</td>
</tr>
<tr>
<td>TECHNICAL CSFs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate ERP Architecture (AEA)</td>
<td>0.916**</td>
<td>H7: Supported</td>
</tr>
<tr>
<td>Strategic IT planning (STP)</td>
<td>0.904**</td>
<td>H8: Supported</td>
</tr>
<tr>
<td>Data Analysis and Conversion (DAC)</td>
<td>0.871</td>
<td>H9: not supported</td>
</tr>
<tr>
<td>ERP Vendor Support (EVS)</td>
<td>0.922**</td>
<td>H10: Supported</td>
</tr>
<tr>
<td>PROJECT CSFs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project tracking (PTG)</td>
<td>0.944**</td>
<td>H11: Supported</td>
</tr>
<tr>
<td>Visible Project Phases(VPP)</td>
<td>0.882</td>
<td>H12: not supported</td>
</tr>
<tr>
<td>Project Phase Update (PPU)</td>
<td>0.907**</td>
<td>H13: Supported</td>
</tr>
<tr>
<td>Interdepartmental Cooperation(IDP)</td>
<td>0.881</td>
<td>H14: not supported</td>
</tr>
<tr>
<td>Interdepartmental Communication (IDC)</td>
<td>0.915**</td>
<td>H15: Supported</td>
</tr>
</tbody>
</table>

As it can be seen from the above Table 1, the important operational CSFs, technical CSFs and project CSFs such as LTS (0.926), CFT (0.912), BPR (0.919), AEA (0.916), STP (0.904), EVS (0.922), PTG (0.907), PPU (0.907), and IDC (0.915) were found to be greatly important as the factor loading shows very high value as suggested by [10]. They argue that the factors showing higher value are critically important although a reasonable value is above 0.5. These CSFs really support the implementation success in Indian ERP projects. Therefore, the hypothesis H1, H4, H6, H7, H8, H10, H11, H13, and H15 were supported toward the implementation success (IS).

LTS is indispensable CSFs in implementing information system (IS) projects such as ERP systems [7] [8] [10]. The organization views the cross-functional teams (CFT) in implementing the ERP systems as a tactical way to use IT and critically necessary to allocate information resources. In order to strengthen the business processes and help organizations to achieve its tactical goals, the result indicates that the involvement of cross-functional teams were necessary. Many researchers [3] [4] [5] [7] [10] argue that there is a misalignment of firm’s expectations and functional process of an enterprise. There is a need to streamline the firm’s functional processes towards the ERP software in order to improve the performance of an organization. A firm understanding of the business processes to determine the appropriate ERP architecture (AEA) for the ERP system is critically necessary because it is the actual blueprint of the project. The Strategic IT planning (STP) CSF plays an important role in the firm to ensure that the overall functional processes are shared across various departments in order to allocate the enterprise resources.

The ERP vendor support (EVS) is essential because it helps to evaluate firm’s application functionality and transform business process from the legacy system to achieve the organizational goals. The project tracking (PTG) factor is crucial and based on techno-functional expertise in going through the project which has spread throughout the ERP
implementation life cycle. The task team also verifies the project schedule and checks the assigned team members who can finish their scheduled job on time. The updating of ERP project phases (PPU) are spread all over the ERP life cycle at regular intervals. Update is also applicable to software version, user manual and other necessary planning documents in the ERP project [10] [17]. The results indicate that the inter-departmental communication (IDC) among various departments is essential and important in the firm since the ERP system’s aim is to integrate all processes in the organization and to develop a communication plan. This plan is meant to provide good information flow to supply necessary data in order to keep users informed about the system’s impact on their responsibilities. The communication plan further helps to reduce the user resistance in the firm.

V. LIMITATIONS, DIRECTION OF FUTURE RESEARCH AND CONCLUSION

There are few limitations of this study. First, the data was collected from India. Therefore, the results may be differed with other developing and developed countries in terms of CSFs for the success of ERP projects. Second, the chosen critical success factors for this study were limited. More CSFs need to be included to see the consistency of the results found out. Third, an in-depth statistical analysis is required to check the importance of CSFs. For instance, SPSS AMOS may give a better result when adopted. Finally, some moderators (for example, political stability or governmental policies) could be used to study the potentiality of CSFs and any influence of these factors to find out the relationship between CSFs and IS.

This paper concludes that the following nine critical factors were very essential in Indian ERP systems implementation: long-term management support (LTS), cross-functional teams (CFT), business process engineering (BPR), appropriate ERP architecture (AEA), strategic IT planning (STP), ERP vendor support (EVS), project tracking (PTG), project phase update (PPU), and inter-departmental communication (IDC). Thus, the ERP project managers should realize the importance of these critical factors in order to reduce the ERP failure rates in India.

The key contributions of this paper are as follows: First, the discussions presented would advance the knowledge management of ERP systems in Indian firms’ which is anticipated to concentrate on the nine CSFs identified in this study. Second, the proposed framework is valuable to those interested in implementing ERP systems in India as well as other countries. Finally, this paper added additional value with the existing ERP literature because of lack of ERP research in India compared to European and Western countries.

REFERENCES