Critical success factors for ERP implementation in SMEs

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ABSTRACT

ERP implementation is regarded as complex, cumbersome and costly, and, very often, it exceeds the initial estimated resources. The process involves a thorough examination of the business processes in the organisation; selection of the best available software solution that matches the requirements of the enterprise; configuration of the selected systems;, training of staff; and customisation of the selected software solutions including development of required interfaces. Finally, the existing MIS of the organisation is replaced totally or partially by the new system. All the implementation processes should be carried out without affecting the daily operations across the whole enterprise. This can only be achieved by having an understanding of the key elements forming the infrastructure of the organisation, an effective plan for the implementation and an effective procedure to measure and evaluate the project throughout the implementation process. This paper presents the results of a study to identify and analyse the interrelationships of the critical issues involved in the implementation of ERP in small and medium sized enterprises (SMEs). Three basic research questions were addressed. First, what are the main critical success factors? Second, how do these factors interact throughout the implementation process? Third, which factors have their highest impact and in what stages? In order to answer these questions, over 50 relevant papers were critically reviewed to identify the main critical success factors (CSFs) for ERP implementation in large organisations. Then, the applicability of the identified CSFs to SMEs was investigated. Next, an industrial survey was also undertaken to identify which CSF has highest impact in what stages. The findings on relationships of the critical success factors have been utilised to develop a tool to monitor, and eventually improve, ERP implementations for SMEs. In the development of the tool, eight people from industry and academia with experience of ERP implementations were interviewed with the aim of validating the model being developed. The overall results provide useful pointers to the interplay of organisational and operational factors for the successful implementation of ERP.

1. Introduction

Enterprise Resource Planning (ERP) is identified as the essential platform upon which companies are building their competitive business process upgrades [1]. In the past, the utilisation of ERP systems has almost exclusively been attributed to large organisations due to the nature of their business and complexity. The cost associated with implementation of ERP systems and difficulties found in achieving management expectations are most significant reasons hindering Small and Medium size Enterprises (SMEs) to adopt the systems. Over the last decade or so implementation of ERP systems in SMEs is becoming common, as the technology is more established and prices come down. This is evident by the fact that a growing number of ERP vendors now focus primarily on SMEs, and also by noting that many of the large ERP vendors such as SAP, and recently Microsoft, are actively expanding their business activities to the SME sector [2], as illustrated by the continuous ERP market growth within SMEs [3]. This growth is attributed to the fact that SMEs have realised the advantages of entirely integrating the information pertaining to all business processes into one system [4]; leading organisations have completely subsumed manufacturing into supply chain, and much of the interaction between customers and suppliers are carried out electronically [1].

According to Davenport [4] ERP solutions are designed to solve fragmentation of information in large business organisations, and integrate all the information flowing within a company. Therefore, integrated systems such as ERP behave like the nervous system of the organisation, with the data resembling nervous impulses. Thus, if nervous impulses are incorrect, then the responses of the functional areas will be inaccurate. SMEs are becoming more and more aware of it, and have realised that integrated systems convert massive amounts of data into accurate

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information in real time, which will allow them to make informed decisions to achieve their business objectives.

Recent research studies reported that enterprises are finding difficulties to achieve the benefits expected from the implementation of ERP systems. Rao [5] estimates that 96.4% of ERP implementations failed, whereas Al-Mashari [6] reports that 70% of the ERP implementations do not achieve their estimated benefits. This suggests that the prospect of implementation of integrated systems is a very bleak picture of the future within SMEs. Although SMEs have advantages such as organisational simplicity, they usually face major problems in shortage of resource and funds [2].

The benefits and disadvantages of the implementation of ERP systems among enterprises have been recently studied the most in Management Information Systems (MIS) field. A large number of investigations have been mainly focused in the identification of the main critical factors for the implementation of ERP systems and their methodologies. The majority of methodologies encourage implementers to face up the implementations like standard projects with a beginning and end or closed loop with different stages rather than a programme. For instance, Sandoe et al. [7], Rajagopal [8] define the implementation process in six stages closed loop. As highlighted by Slack et. al. [9], there is a clear distinction between project and programme; a project is a set of activities with a defined start point and a defined end state, which purposes a defined goal and uses a defined set of resources; a programme is a continuous process, which has no defined end point. Accordingly, ERP implementation cannot be treated as a project or a temporary process but should be considered as a dynamic and continuous process with no end.

Literature on ERP implementations recognises that a common problem among ERP programmes is to assume that the ERP programme finishes after the system goes live. A study carried out by Metagroup pointed out that 36.2% of the respondents broke-up the implementation team after the system went live. As a result, these enterprises experimented negative effects of losing business/IT alignment continue to grow with time [10]. It is due to the fact that ERP programmes have been historically associated to IT projects, rather than aligning management techniques, business process, organisational structure, organisational culture, information systems and technology within the organisation. This alignment involves a large number of dynamic factors that interact and impact among them. The identification of critical factors for the implementation of ERP systems has been well defined within the literature. However, the interaction and impacts among the critical factors have not been investigated in detail.

This research aims to develop a methodology and a prototype system to help measure performance based on the interrelationships of the critical success factors (CSFs) for totally integrated systems at any stage of the implementation. In this paper we aim to answer the following assumptions:

Assumption 1. ERP systems require emphasis on both organisational and operational factors during the implementation.

Assumption 2. Organisational factors play a more important role than the operational factors in the implementation.

Assumption 3. The lack of success in achieving the CSFs in the initial stages of ERP implementation might lead to poor integration of the enterprise.

To verify these assumptions, this paper identifies critical success factors in the implementation process through literature review, industrial survey and interviews with managers in eight enterprises of the North-East of UK. The interrelationships and

impacts among the selected CSFs were analysed using a cross-reference analysis methodology. The remaining sections of the paper describe the identification of the CSFs, their classification as organisational and operational factors and analysis of their interrelationships in details. Finally conclusions of the study are presented.

2. Critical success factors for implementation of ERP programmes

ERP implementations are complex as the large number of internal and external factors are involved within the implementation process. Many research studies [11–14] have clearly suggested that ERP implementations are not standard projects and neither are IT projects. The implementation of such systems requires effective participation of the whole organisation. Despite of the awareness of the problems associated to ERP implementations, still the majority of enterprises failed due to the lack of their consideration of organisational factors such as interdepartmental communication and cooperation, implementation management and management support.

Rockart [15] introduced a Critical Success Factors (CSFs) approach to information systems. Rockart defined CSFs as "…the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation. They are the few key areas where things must go right for the business to flourish. If results in these areas are not adequate, the organisation's efforts for the period will be less than desired".

After the Rockart [15] study, many research studies have been carried out for the identification of CSFs for the implementation of ERP systems. The two most remarkable studies, related to the identification of CSFs in ERP implementation, were conducted by Somers and Nelson and Esteves-Sousa and Pastor-Collado. Somers and Nelson described the impact of CSFs among the stages of the ERP programme, by carrying out a meta-study based on a review of the literature on IT implementation, business process re-engineering (BPR), project implementation and descriptions, case studies of ERP implementations of over 110 companies in the popular literature and responses from 86 organisations involved in ERP implementation. Esteves-Sousa and Pastor-Collado [16] developed a unified CSFs model and analysed the CSFs relevance along the implementation phases. This study reviewed over 50 papers relevant to the identification of CSFs for the implementation of ERP systems. The list of CSFs identified with their IDs are presented in Table 1 with their frequency of occurrence mean. Fig. 1 presents a graph of occurrence percentage of the CSFs.

Analysing the occurrence of the CSFs within the literature as presented in Fig. 1, it is observed that management support (ID17), interdepartmental communication (ID13), business process re-engineering (ID8), project team skills (ID15), interdepartmental cooperation (ID14), project management (ID4), evaluation progress(ID18) and clear goals (ID33) and objectives were the most frequently highlighted by the authors.

3. Analysis of critical success factors' relationships

ERP system has become the replacement for disparate disintegrated systems for many companies, including SMEs. To adapt the supply chain systems a higher level of data integration among enterprises is essential the understanding of the interrelationship of CSF. It is crucial due to the fact that the lack of performance in decisive CSFs might affect seriously in the performance of other CSFs, unleashing a domino effect among the implementation.

ERP literature has clearly identified which are the main Critical Factors for the implementation of ERP systems as described in the previous section. The literature review in this study indicated that there is still a clear gap in the understanding of how each factor might affect each other and their consequences. The following subsections will present the analysis of their interrelationships between different factors.

3.1. Identification of organisational and operational levels

From the literature review, it was observed that many implementations have been treated more from the operational than the organisational point of view. As a result, a large number of implementations have found difficulties to achieve the benefits expected. Rivard et al. [17] state that information technologies are neutral, their impact depending on the way they are implemented and used in a given environment. According to Schneider [18]

Table 1
Identification of critical success factors (CSFs).

ID	CSFs	Occurrence (%)
ID1	Good project scope management	26.32
ID2	Management expectations	21.05
ID3	Formalised project plan/schedule	63.16
ID4	Project management	68.42
ID5	Steering committee	26.32
ID6	Legacy systems	36.84
ID7	Cultural change/political issues	57.89
ID8	Business process reengineering (BPR)	78.95
ID9	Experienced project manager-leadership	63.16
ID10	Project champion role	47.37
ID11	Adequate resources	42.11
ID12	Trust between partners	15.79
ID13	Interdepartmental communication	84.21
ID14	Interdepartmental cooperation	73.68
ID15	Project team composition/team skills	78.95
ID16	Empowered decision makers	15.79
ID17	Management support and commitment	100.00
ID18	Monitoring and evaluation progress	68.42
ID19	Appropriate use of consultants	57.89
ID20	Vendor's tool	21.05
ID21	Managing consultants	21.05
ID22	Software customisation	36.84
ID23	Software configuration	31.58
ID24	Appropriate technology	26.32
ID25	Reduced trouble shooting-project risk	42.11
ID26	Training on software	52.63
ID27	Education on new business processes	42.11
ID28	Vendor support	26.32
ID29	Data analysis and conversion	15.79
ID30	Formal methodology-ERP implementation strategy	63.16
ID31	Carefully defined information and system requirements	52.63
ID32	Adequate ERP software selection	52.63
ID33	Clear goals and objectives	68.42

one difficulty in implementing ERP systems is this switch from a functional to a process orientation, due to the fact that modules cut across traditional department lines. It is due to the fact that technical solutions such as an ERP system do not induce necessarily the expected changes, it is not because of the technology. Technology itself does not provide from the cultural changes required, it is only people, who make it happen by coordinating and aligning the company business with the technology.

The CSFs identified in the literature survey [20,21] were classified in three categories, organisational and cultural factors as organisational CSFs; operational and technical factors as operational CSFs; and neutral CSFs, which cannot clearly be defined as organisational or operational factors. In order to identify which factor is organisational, operational or neutral, a survey was conducted with four academics experienced in ERP systems and 16 managers directly involved in ERP implementations. Based on their experience and subjective judgement, the respondents decided the organisational and operational percentage involved in each CSF. The data obtained from the survey was analysed by using MINITAB with 95% confidence interval for mean. The values outside of the lower and upper boundaries (provided by Minitab) were removed in order to have a better approach. The results obtained from Minitab for operational factors are presented in Table 2.

As shown in Table 2, the organisational percentages that are in more agreement among the participants are: monitoring the implementation process; educating people on the new business process; and cultural change. While the CSFs that are in more disagreement are: reduce the trouble shooting-project risk, management support, leadership and identification of system requirements. From the results obtained, the 33 CSFs have been classified in three categories based on the organisational percentage involved in each CSF. For the purpose of this investigation, it has been considered organisational factors as those CSFs that their organisational level is higher or equal to 60%, neutral between 40 and 60 (boundaries not included) and Operational lower or equal than 40%. Following this categorisation, it was found that 51.5% of the CSFs can be considered as organisational, 42.4% as operational, while 6% as neutrals. The results are summarised in Table 3.

As shown in Fig. 2 and Fig. 3, the implementation process is clearly stated by two areas that tend to converge into a neutral area. The analysis on how organisational and operational factors interact among the stages of the implementation of integrated systems are briefly presented in Section 3.3 of this paper.

The results obtained in this investigation reveal that the performance within the ERP implementation process is predetermined by the balance of success within the organisational and operational factors. Therefore, the difficulties in reaping the benefits from ERP systems might be attributed to the lack of consideration to the organisational or the operational CSFs areas. This justifies Assumption 1 that ERP systems require equal consideration on organisational and operational factors during implementation.
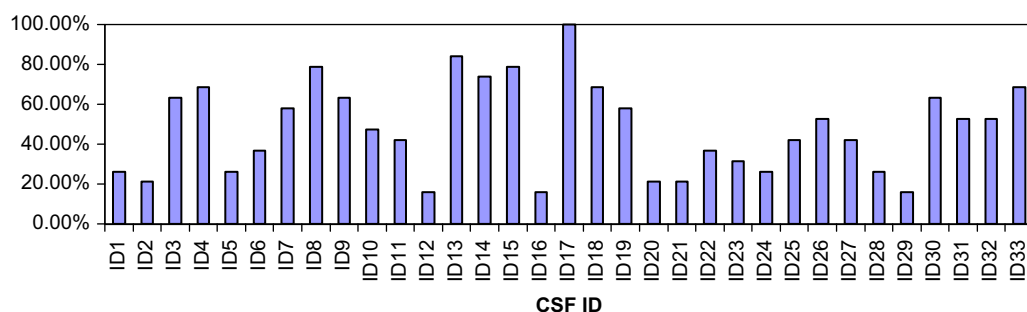

Fig. 1. The occurrence of the critical success factors (CSFs) within the literature.

Table 2
Operational factors of CSFs.

ID	CSFs	N	StDev	Mean
1	Good project scope management	15	6.04	6
2	Management expectations	17	4.24	23.53
3	Formalised project plan/schedule	16	4.64	84.69
4	Project management	16	4.73	86.56
5	Steering committee	16	5.19	6.25
6	Legacy systems	17	5.07	35.88
7	Cultural change/political issues	18	5.32	61.11
8	Business process reengineering (BPR)	13	4.63	86.15
9	Experienced project manager-leadership	11	3.83	83.18
10	Project champion role	14	0	90
11	Adequate resources	15	4.71	24
12	Trust between partners	13	4.39	22.69
13	Interdepartmental communication	12	6.15	78.33
14	Interdepartmental cooperation	15	5	45
15	Project team composition/team skills	12	4.91	77.5
16	Empowered decision makers	16	4.37	26.56
17	Management support and commitment	11	4.72	75.45
18	Monitoring and evaluation progress	19	4.17	96.053
19	Appropriate use of consultants	14	2.486	78.214
20	Vendor's tool	17	4.76	15.88
21	Managing consultants	17	4.57	8.82
22	Software customisation	16	7.74	42.81
23	Software configuration	15	5.16	4.67
24	Appropriate technology	15	5.73	16
25	Reduced trouble shooting-project risk	10	4.59	76
26	Training on software	14	4.64	85.57
27	Education on new business processes	18	4.5	25.56
28	Vendor support	17	4.93	13.53
29	Data analysis and conversion	15	2.44	28.333
30	Formal methodology-ERP implementation strategy	12	5.57	67.5
31	Carefully defined information and system requirements	11	5.05	88.64
32	Adequate ERP software selection	16	5.73	91.88
33	Clear goals and objectives	17	4.37	87.35

Table 3
Organisational and operational factors in CSFs.

Organisational factors	Neutral factors	Operational factors
CSFs for implementation of ERP systems • Formalised project plan/schedule • Project management • Cultural change/political issues • Cultural change/political issues • Business process reengineering (BPR) • Experienced project manager-leadership • Project champion role • Interdepartmental communication • Project team composition/team skills • Management support and commitment • Monitoring and evaluation progress • Appropriate use of consultants • Reduced trouble shooting-project risk • Training on software • Formal methodology-ERP implementation strategy • Carefully defined information and system requirements • Adequate ERP software selection • Clear goals and objectives	• Interdepartmental cooperation • Software customisation	• Good project scope management • Management expectations • Steering committee • Adequate resources • Trust between partners • Empowered decision makers • Vendor's tool • Managing consultants • Software configuration • Education on new business processes • Vendor support • Data analysis and conversion

3.2. Identification of CSFs interrelationships

A cross reference model (Fig. 4) was used to investigate how each CSF might impact within the implementation process. The cross-reference analysis identifies which CSFs are more impacted as well as with highest impact among the implementation process. It will allow implementers to have a clearunderstanding during the implementation process of the areas needed for improvement and their effects in the overall implementation.

Furthermore, this study is investigating the levels of organisational and operational involved in each CSF.

A cross-reference analysis was done by carrying out a survey among enterprises based in the North East of United Kingdom with the aim of weighting the impact of each CSF among the others. The survey was conducted with eight managers, which are or have been recently involved within the implementation of ERP systems. A database, which contains 33 questionnaires, was developed in Microsoft Access. The application was developed

with the aim of facilitate the analysis and completion of the questionnaires. The questionnaire was done with the intention of measuring how each variable (CSF) might affect into the others, using permutation combinations.

The impact of each variable into the others was weighted in five categories (none, poor, average, high and very high) and measured from 0 to 5. The final score for each individual variable was worked out using a ranking method. Only the most significant variables, from the results obtained, were taken in consideration for further analysis based on the Pareto's rule, also known as 80/20. The final data was exported into an Excel spread sheet to analyse the impact that each variable has into the others, as well as, how they are impacted. The results were mapped in a matrix (Table 4), where the "No of Impacts" represents the number of CSF that will be affected by, while the "Impact" represents the number of CSFs it will affect.

From the results obtained in Fig. 5, experienced project manager; use of consultants; resources; interdepartmental cooperation; cultural change; interdepartmental communication; project team skills; management support; evaluation progress; and data analysis, represent 30% of the CSFs with higher impact into others CSFs, which have been selected for further analysis.

From the critical success factors (CSFs) selected for further analysis, it is found that 80% of them are more organisational than operational. Therefore, this justifies Assumption 2 that organisational factors play a more critical role than the operational factors within the implementation process.

3.3. Analysis of impacts of the CSFs

At this stage of the investigation, only the 10 most significant CSFs have been taken in consideration, which are presented in
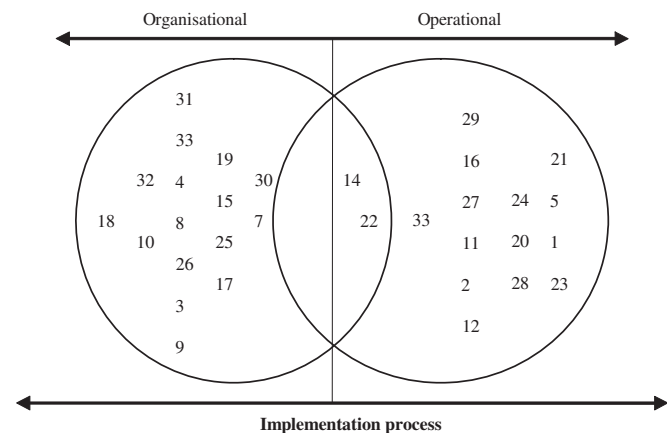
Table 5 for the analysis of how each CSF impacts on the others and the others impact it. Based on the information analysed and presented in Table 4, the interactions among the CSFs have been presented in Fig. 6.

Analysing the ten significant factors, it is found that among the most significant CSFs, the CSFs can be grouped into three different interaction categories.

- *Basic:* The factors included in this category are those, which impact other CSFs, but others do not significantly impact them. These CSFs are associated to the initial state of the enterprise and willingness to implement an integrated system. This process is normally covered by the initiation and selection stages. The initiation stage involves the consensus of the company of the need of an ERP system that will best address the critical business challenges and improve the organisational strategy. According to Esteves and Pastor [19] this phase includes the definition of system requirements, its goals and benefits, and an analysis of the impact of adoption at a business and organisational level. The selection stage involves the agreement of resources required and the acquisition of the software that best fit with the company requirements.
- *Critical:* the factors included in this category are those CSFs which are impacted by the basic factors and they have a notably impact from others. These CSFs are related to the implementation of the acquired integrated system within the organisation. Rajagopal [8] defines this process in two stages, the adaptation stage where the user's enterprise start using the system, but without clear understanding of the system; and the acceptance when the users after being using it start
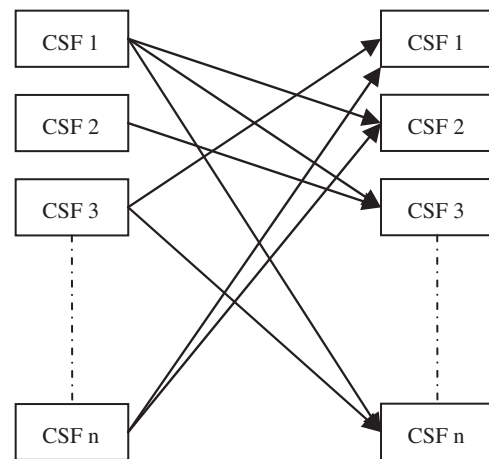

Fig. 2. Organisational & Operational CSFs within the implementation.

Fig. 4. Analysis approach to identify interrelationships among CSFs.

Fig. 3. Operational and organisation levels of CSFs.

Table 4
CSFs Matrix.

CSFs ID	1	2	3	…	30	31	32	33	Total score	No of impacts
1	0.00	0.27	0.26	…	0.22	0.00	0.00	0.00	**1.66**	**7**
2	0.23	0.00	0.22	…	0.00	0.00	0.00	0.24	**1.54**	**7**
3	0.21	0.22	0.00	…	0.00	0.00	0.00	0.00	**1.61**	**7**
…	…	…	…	…	…	…	…	…	…	…
30	0.00	0.23	0.28	…	0.00	0.19	0.00	0.00	**1.80**	**8**
31	0.00	0.19	0.00	…	0.00	0.00	0.00	0.00	**1.43**	**6**
32	0.00	0.00	0.00	…	0.00	0.00	0.00	0.00	**1.98**	**8**
33	0.28	0.27	0.25	…	0.00	0.00	0.00	0.00	**1.72**	**7**
Score	**2.19**	**4.28**	**2.68**	…	**0.91**	**1.74**	**2.17**	**2.40**		
Impact	**9**	**18**	**11**	…	**4**	**8**	**9**	**10**		
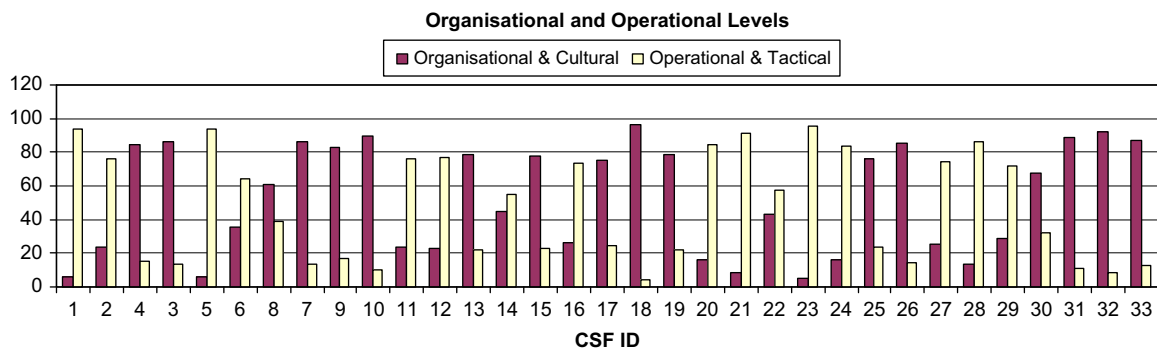
Fig. 5. Interrelationship impact of CSFs.

Table 5
Interaction classification of critical success factors (CSFs).

Classification	CSFs
Basic	Project team skills
	Experienced project manager
	Resources
	Data analysis
Critical	Cultural change
	Use of consultants
	Management support
Dependent	Cooperation
	Evaluation progress
	Communication

acquiring a better appreciation of the system benefits and capabilities. These stages involve the initial configuration of the integrated system to align the critical business of the organisation with the functionalities of the system, data migration, training and cultural change.

- *Dependent:* factors included in this category are those factors which are highly impacted by other CSFs. These CSFs are associated to the process of tuning the system in order to achieve the maximum number of benefits from the system. This process involves the acceptance of the cultural change within the company; evaluation of the integrated system within the departmental areas of the organisation; software customisations; the expansion of the system to other functional areas of the company and further upgrades.

The overall findings of this study are summarised on Table 6 in relation to the various stages of implementation of ERP systems. It

is observed that as the implementation progresses the level of interaction among the CSFs also increases. As a result, the poor performance in any those CSFs will affect to the performance in the next implementation stages. Therefore, this justifies Assumption 3 that the lack of success in achieving the CSFs in the initial stages of ERP implementation might lead to poor integration of the enterprise. The detailed analysis on how CSFs play different role in various stages of implementation will be present in next paper.

4. Conclusions

Throughout a literature survey, 33 CSFs related to implementation of ERP systems were identified. These CSFs were classified from the organisational and operational point of view, based on academic and managers criteria. Analysing the impact of organisational and operational factors, it is found that despite the number of organisational factors is very close to the number of operational factors, the organisational factors play a most important role within the implementation, where 80% of ten top CSFs were identified as an organisational.

The investigation highlighted the interrelationship of the top 10 CSFs, which were classified into basic, critical and dependent based on their interaction level among the CSFs. Analysing the interaction among the CSFs, it is was found that as the implementation process progresses, the number of factors involved within the implementation and their interaction also increase. Therefore, the individual evaluation of each CSF involved in the implementation process is crucial to reduce the number of difficulties encountered in the past and maximise the benefits from the implementation of ERP systems.

Further research is being carried out to study in which stage each CSFs might have its critical role and their impact as overall. It is anticipated that the holistic view of the interrelationship of
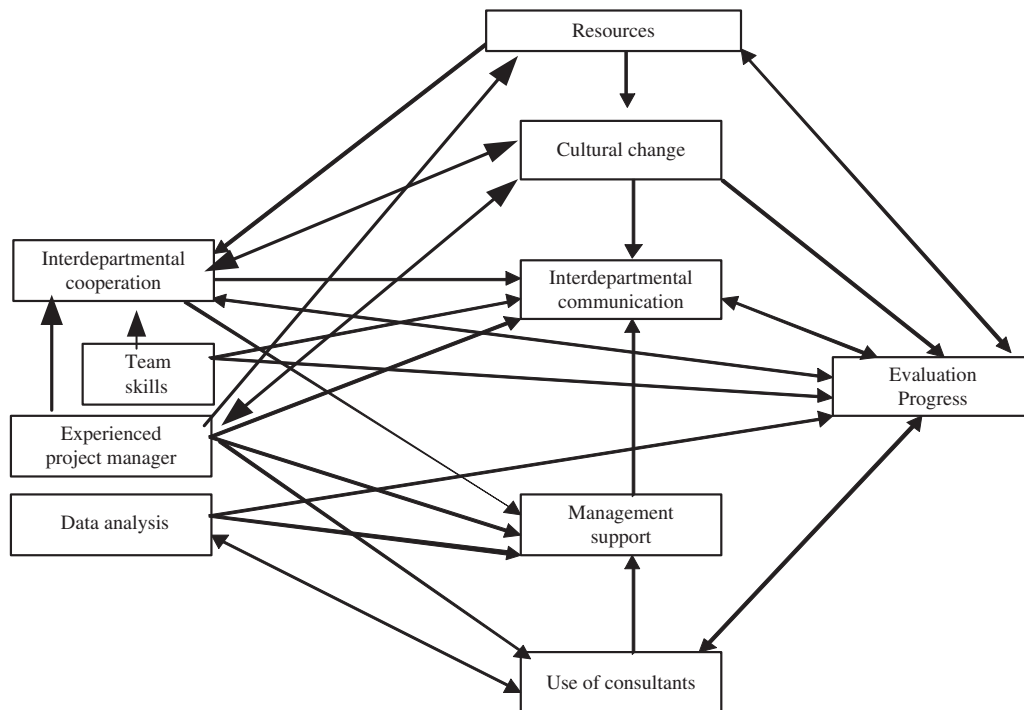
Fig. 6. Relationship of critical success factors (CSFs).

Table 6
CSFs impact.

Classification	Stages	CSFs	Impact	Factor
Dependent	6-Infusion	Evaluation progress	8/10	Organisational
		Communication	6/10	Organisational
	5-Routinisation	Cooperation	5/10	Organi/Operat
Critical	4-Acceptance	Cultural change	4/10	Organisational
		Management support	3/10	Organisational
	3-Adaptation	Use of consultants	3/10	Organisational
Basic	2-Adoption	Resources	2/10	Operational
		Data analysis	1/10	Operational
		Experienced project manager	0/10	Organisational
	1-Initiation	Project team skills	0/10	Organisational

CSFs among the different stages of the implementation would provide a better approach of identifying KPIs for measuring the implementation. SMEs will be able to benefit in implementing ERP systems.

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