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Preventing failure in IT-enabled systems for supply chain management

Javad Soroor[ab]*, Mohammad J. Tarokh[b] and Manijeh Keshtgary[a]

[a]*Department of Computer and Information Technology Engineering, Shiraz University of Technology, Shiraz, Iran;* [b]*Industrial Engineering Department, K. N. Toosi University of Technology, Tehran, Iran*

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Supply chain management (SCM) emphasises the overall and long-term benefit of all parties on the chain through cooperation and information sharing. This signifies the importance of communication and the application of IT-enabled systems in SCM. A supply chain management information system (SCMIS) is usually user-interfaced and designed to provide information and information processing capability to support the strategy, operations, management analysis, and decision-making functions in an organisation's supply network. SCMIS provides high quality, relevant and timely information flow that effectively supports decision-making for inventory replenishment, capacity activation, and for synchronising material flows at all tiers within the supply chain. In recent years, there have been some efforts on designing efficient information systems for supply chain management; but many of them have led to failure. Using a critical failure factor (CFF) approach and based on a perfect study, we investigate this crucial issue in-depth and put forward feasible solutions regarding failure prevention in such systems throughout this article. Three main purposes of this paper are to: (1) identify SCMIS and its characteristics, (2) introduce and categorise the critical failure factors of SCM and SCMIS, and (3) investigate the explanatory power of these CFFs on the performance of supply channel processes performed through SCMIS.

Keywords: supply chain management; process coordination; information system; critical failure factor; information technology

1. Introduction

1.1 *Background*

Considering the significance of process coordination in supply channels, and taking account of the enormous capabilities and potentials of modern information and communication technologies, it is almost impossible to achieve an effective supply chain without some support from information technology-enabled systems (Soroor *et al*. 2009a). Since suppliers are usually located all over the world, it is essential to integrate the activities both inside and outside of an organisation (Soroor *et al*. 2009b). This requires an integrated information system (IS) for sharing information on various value-adding activities along the supply chain. Information technology (IT) is like a nerve system for

*Corresponding author. Email: Soroor@sutech.ac.ir

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supply chain management (SCM) (Yamaya 2002). On the other hand, the successful development of information systems for supply chain management is not easy for any organisation. In recent years, there has been some effort spent at designing efficient information systems for supply chain management; but many of them have led to failure. Even if we succeed to design such information systems, implementation success cannot be taken for granted and even successful implementations might not be used as intended. Furthermore, critical success/failure factors applicable to other types of information systems may not necessarily apply to information systems for supply chain management.

Hence, as supply chain management information systems (SCMIS) and their derivatives are offered by an increasing number of vendors and supposedly used by more and more organisations, understanding the determinants for their successful implementation and use becomes increasingly important. Interestingly enough, little research has been carried out concerning this subject matter (Flowers 1997).

To date, it has not yet been determined if the SCMIS critical failure factors (CFFs) are universal in their application to different organisations, business environments, and culture, or if they are an artefact of prevailing company and country cultures (Poon and Wagner 2001). However, in this article we have done our best to examine these systems in disparate environments, and based on the findings of experts in the pertaining fields, we have recognised and categorised the main CFFs carefully.

1.2 *Purpose and contents*

The purpose of this paper is to illustrate and describe critical failure factors for a functioning supply chain management information system. To attain our purpose, we need to attain more knowledge about the information systems as a whole and SCMIS in particular.

The article is organised as follows. In Section 2 we will briefly describe the basics of a supply network and supply chain management. This will be followed by the definition and characteristics of supply chain management information systems in Section 3. Then, in Section 4, SCMIS failure and its notions will be considered. The majority of remaining text is devoted to the subject matter of our work in Sections 5 and 6: SCMIS critical failure factors before and after implementation, followed by discussion. The manuscript ends with conclusions and suggestions for future research.

2. Supply chain and its management

2.1 *Supply chain*

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers (Kaihara 2003).

The supply chain can be regarded as a business process to construct enterprise-wide methods. It is defined in many ways. The International Center for Competitive Excellence defined it to be ‘the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders’ (Liu *et al.* 2005).

2.2 *Supply chain management*

Supply chain management (SCM) is mostly about effectively integrating the information and material flows within the demand and supply process (Soroor and Tarokh 2006a). The potential for improved productivity, cost reduction and customer service are enormous. Of course, the benefits are based on effectively employing the right processes and supporting information technology. This is a higher priority than ever before (Simchi-Levi *et al*. 1999).

SCM is based on the integration of all activities that add value to customers starting from product design to delivery (Verwijmeren 2004). According to Simchi-Levi *et al*. (2004, 2005), SCM is a set of approaches utilised to effectively integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimise system-wide cost while satisfying service level requirements.

3. Supply chain management information systems

3.1 *Definition of SCMIS*

The term 'information system' has been defined to denote any of a wide combination of computer hardware, communication technology, and software designed to handle information related to one or more business processes (Flowers 1996). It serves to coordinate the work of many different organisational functions, from a back office administration support, to a company's strategic management tool. The payroll, sales orders, inventory control, and personnel records systems are some examples of back office administration support systems. For industries such as banking, travel, and insurance, information systems are part of the operating core of the organisation. Implementation of an information system involves the design, delivery and use of the software system in the organisation (Soroor *et al*. 2009a).

The subject of IS studies is interdisciplinary, integrating technological disciplines with management and other disciplines such as psychology and sociology (Avison and Fitzgerald 1995).

Supply chain management emphasises the overall and long-term benefit of all parties on the chain through cooperation and information sharing. This signifies the importance of communication and the application of IT in SCM (Yu *et al*. 2001). An SCM information system is user-interfaced and designed to provide information and information processing capability to support the strategy, operations, management analysis, and decision-making functions in an organisation's supply network. The system uses IT, manual procedures, models, and knowledge bases and databases (Shemshadi *et al*. 2008). Applications may improve operational efficiency, improve and innovate functions, or restructure business processes. An information system stores, processes, and delivers information relevant to an organisation's supply chain, in such a way that the information is useful to those who wish to use it, including managers, staff, customers, and suppliers. An information system may or may not involve the use of computer systems (Yeo 2002).

3.2 *Basis for the existence of SCMIS*

Information has a meaning and use to a particular recipient in a particular context. It comes from selecting, summarising, and presenting data in such a way that it is useful

to the recipient (Soroor *et al.* 2009a). Information is also defined as structured data that has a contextual meaning. It provides the user with the knowledge to make the necessary decisions. SCMISs thus are supposed to inform people (who in the IT context are called users or clients) and this is the primary objective of the existence for SCMISs (Bell and Wood-Harper 1998). From the systems thinking view, information systems exist to serve, help or support people taking action in the real world. The 'action' of the real world could mean anything from increasing the efficiency of the workforce to consolidating the resources under the power and control of one person. The objective of SCMIS existence is sometimes mixed with politics which are hard to detect.

3.3 *SCMIS advantages*

SCMIS provides high quality, relevant and timely information flow that effectively supports decision-making for inventory replenishment, capacity activation, and for synchronising material flows at all tiers within the supply chain. It grants regularity and speed to the current SCM processes and prevents supply channel activities from getting too complicated and hard to perform. The ultimate goal of developing and implementing SCMIS, in spite of the high related costs, is to increase SCM performance up to an acceptable level and facilitate all the processes necessary to perfectly accomplish supply network tasks.

4. SCMIS failure and its notions

4.1 *SCMIS failure*

SCMIS fails if any of the following situations occur (Soroor *et al.* 2009b):

(1) when the system as a whole does not operate as expected and its overall performance is sub-optimal;
(2) if, on implementation, it does not perform as originally intended or if it is so user-hostile that it is rejected by users and underutilised;
(3) if, the cost of the development exceeds any benefits the system may bring throughout its useful life; or
(4) due to problems with the complexity of the system, or the management of the project, the SCM information system development is abandoned before it is completed.

The failure factors can be broadly grouped in the organisational and managerial contexts and the actual conduct of a SCMIS development project. Possible failure factors in the organisational and managerial contexts include hostile company culture, improper reporting structure, political pressures, vested interests, influences, and inappropriate level of management commitment.

Key influencing factors in the conduct of the project itself include pre-occupation with technology in project planning, technology focus over human relations, complexity underestimated, poor stakeholder management, poor consultation, design by committee, technical fix for a management problem, poor competence of project management and project team, and poor selection decisions (Bolstorff 2003).

4.2 *Failure notions*

4.2.1 *Major categories of SCMIS failures*

There are four notions or categories proposed for SCMIS failures (Soroor *et al*. 2009b):

(1) *Correspondence failure:* When the system design objectives are not met, the SCM information system is considered a failure. It is generally believed that design goals and requirements can be specified clearly in advance, and that their achievements can be accurately measured. Performance measures mainly based on cost–benefit analysis are employed for managerial control over the system's implementation. Correspondence failure, goal seeking in outlook, tends not to recognise that users may not necessarily accept systems that meet design objectives and specifications.
(2) *Process failure:* A process failure occurs when a SCMIS cannot be developed within an allocated budget, and/or time schedule. There are two likely outcomes of process failure. Firstly, an outright failure occurs when no workable system can be produced. Secondly, a more common outcome is when a SCMIS is developed with massive overspending in both cost and time, thus negating the global benefits of the system. This is a project level failure attributed to unsatisfactory project management performance.
(3) *Interaction failure:* The level of end-user usage of the information system is suggested as a surrogate in SCMIS performance measurement. Some related measures of SCMIS usage include user attitudes and user satisfaction, the amount of data transferred or the frequency of use. However, heavy usage does not necessarily mean high user satisfaction and improved task performance, and there is little empirical evidence supporting such a claim. Heavy systems usage might be a result of legal compulsion, persuasion, or that there are simply no other alternatives besides using the system.
(4) *Expectation failure:* The notion of expectation failure views SCMIS failure as the inability of a system to meet its stakeholders' requirements, expectations, or values. Failure, therefore, does not only involve the system's inability to meet design (technical) specifications. Expectation failure is perceived as the difference between the actual and desired situation for the members of a particular stakeholder group. Unlike the other three notions, SCMIS failure is considered holistically in this case, as the views of different stakeholders are taken into account.

4.2.2 *Termination failure*

Sauer (1993) proposes that systems should be considered as a failure only if there is a development or operation termination. Based on this criterion, the failure model takes the natural systems approach, which explains systems behaviour in terms of the goal of survival. This approach describes the achievement of survival through acting on the environment so as to obtain necessary resources (funding) that in turn support the system's continued operations.

A system is not considered a failure as long as it survives and continues to attract support in resources. The concept first considers SCMIS as a product of a coalition of stakeholders, which includes project organisation, which assumes the major part of developing, operating, and maintaining the SCMISs in question. With support and

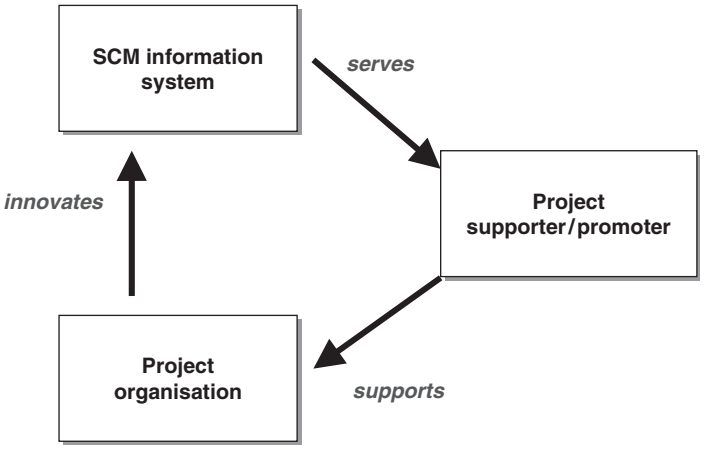

Figure 1. Triangle of dependences.

commitment from the supporters or promoters, the project organisation is able to carry out its work, ideally with a view to serve the interest of the supporters. This creates a 'triangle of dependences' as illustrated in Figure 1. Failure occurs when the level of dissatisfaction with a system rises to the extent when there is no longer enough support to sustain it. SCMIS failure is indicated by the cessation of all the work related to the supply network. Termination failure thus refers to a total abandonment of the SCMIS project.

5. SCMIS critical failure factors

5.1 *Critical failure factors pertaining to SCM performance*

In order to make a better perspective of what we will cover in the next sections, we should mention the typical critical failure factors pertaining to how supply chain management is performed. These CFFs are derived from deep studies and exact investigations, and they are categorised in Table 1.

5.2 *SCMIS development failure factors*

There are several critical factors that ignoring them during the development of supply chain management information system will lead to failure in the performance of the supply network. Depending on the development environment, CFFs proposed for SCMIS development may be slightly different (Peterson *et al.* 2002). In our study, we tried to determine the most common of them. These critical failure factors are listed in Table 2.

5.3 *Critical failure factors within SCMIS*

The same as any other system, a SCMIS has some structural components that are joined together in order to perform the system's goals and fulfil the desired activities. Typical CFFs inside a SCMIS are discussed in this section.

Table 1. Critical failure factors pertaining to SCM performance (Tarokh and Soroor 2006).

Category	CFFs
Asset management	• No control on inventory levels, obsolete inventory, and inventory turns. • Low return on net assets. • Lack of inventory classification. • Low return on investment.
Cost	• Mismatch of actual costs versus budget. • Disregarding inbound/outbound freight. • Intolerable total cost (logistics). • Lack of cost trend analysis. • Cost per unit. • Ignoring cost of damage. • Sub-optimum warehouse order processing. • High inventory carrying cost. • Disregarding the cost of returned goods. • Low profitability of direct product. • High cost of service failure. • High cost of backorder.
Productivity	• Low productivity of warehouse labour. • Lack of goal programmes. • Low rate of units shipped per employee. • Lack of productivity index. • Low rate of units per labour dollar. • Uneconomical equipment downtime. • Low productivity of transportation labour.
Customer service	• Lack of commitment to on-time delivery. • Stock-outs. • Shipping errors. • Low fill rate. • Lack of delivery consistency. • Long cycle time. • High rate of backorders. • Customer complaints. • Overall customer dissatisfaction. • Overall unreliability. • Dissatisfiedly response time to inquiries. • Sales force complaints. • Lack of response accuracy.
Logistics quality	• Number of customer returns. • Lack of picking/shipping accuracy. • Number of credit claims. • Damage frequency. • Lack of document/invoicing accuracy. • Lack of order entry accuracy. • Lack of information availability. • Lack of information accuracy.

5.3.1 *Inappropriate SCMIS staff*

The quality of the staff that support an IS for SCM is important. The project manager should have technical as well as business knowledge, and the ability to communicate with

Table 2. Eighteen SCMIS development failure factors.

- No attempt on reengineering business process.
- Insufficient peer review on project progress.
- Inadequate training for the team members.
- Lack of user participation in the project.
- Lack of team member commitment.
- Lack of top management support.
- Lack of clearly stated objectives.
- Inexperience of team members.
- Lack of detailed project plan.
- Improper project scope.
- Inexperience of project leader.
- Use of inappropriate technology.
- Little use of utilising a prototype.
- Lack of team member self-control.
- Utilising an ineffective methodology.
- Lack of project leader's feedback to team.
- Ill alignment of project and corporate goals.
- Lack of project leader's monitoring/control.

senior management. Support staff must be sophisticated enough to interact with top management and be able to master the technologies required for the system (Stadtler 2004).

5.3.2 *Inappropriate technology*

The choice of hardware and software has a major bearing on the acceptance of a system. In the past, a barrier to executive support was the lack of hardware and software that fit with the demands of highly variable work styles and environments of supply chains. As more specifically designed products have become available, this problem has diminished. Development is now often replaced by selecting the most appropriate system on the market.

5.3.3 *Ill management of data*

The ability to provide access to reliable data from both internal and external sources is a major issue in the system development. Aggregating, accessing, and extracting data from a number of subsidiary databases can be a stumbling block to the implementation of an IS suitable for SCM.

5.3.4 *Lack of a clear link to business objectives*

The system must solve a defined supply chain problem or meet a need that can be addressed effectively with IS technology. There should be a clear link to business objectives and clear benefits in using the technology. The system must provide something that would not otherwise be available and add value to the data.

5.3.5 *Ill management of organisational resistance*

Organisational resistance is a common cause of implementation failure. As an IS for supply chain can alter the information flow in an organisation and shift the power relationships

within a company, there may be resistance to its introduction and operation (Schönsleben 2004). Handling of this potential conflict source will remain an issue throughout the life of the system. For instance, implementing such a system may encounter the resistance of individual groups who insisted on keeping their own data collection techniques.

5.3.6 *Ill management of system evolution and spread*

An installation that is successful will almost inevitably produce demand by peers or subordinates for access to a similar system. Managing this process of 'spread' means identifying the specific job function, technical orientation, work style, and specific information support needs of each potential user (customer or supplier), and taking that into account when expanding the system.

5.3.7 *Lack of an evolutionary development methodology*

An evolutionary development methodology is widely acknowledged as a key factor for a system's success (Houdeshel and Watson 1987). The most common way of finding how the technology can provide value for the supply chain management is through prototyping (Soroor *et al*. 2009a).

5.3.8 *Lack of carefully defined information and system requirements*

A key design issue is identifying the supply chain management information requirements (Soroor *et al*. 2009b). A successful system can only be delivered when the SCM needs are understood. Getting supply network managers and executives to specify what they want is not an easy task. Identifying SCM's information requirements is the biggest challenge faced by the development team (Paller and Laska 1990). One may observe differences in SCM information needs based on different information search behaviour (Vandenbosch and Huff 1997). Even experienced IS consulting firms may find it difficult to identify SCM information needs.

5.3.9 *Ill management of change*

Change is inevitable when dealing with SCM projects and thus change management is a fundamental activity in any SCM project including SCMIS. This change can occur within the information system or be provoked by outcome (Milis and Mercken 2002).

5.3.10 *Weakness of decision making process*

The decision making process is one of the most important aspects of SCMIS and has an outstanding role in its performance. It is recommended that the new methods of decision making such as distributed decision making (DDM) be applied in SCMIS. Utilising a wrong process for finding a solution may lead to system's failure.

5.3.11 *High implementation and maintenance costs*

Implementing SCMIS is possible only if the analysis and design phases of system development life cycle (SDLC) are successfully passed (Lambert 2005). These processes are time and money-consuming and usually impose high implementation and maintenance

costs on organisations. Due to this problem, many SCMIS projects lead to failure, especially in third world countries' organisations.

5.3.12 *Insufficient commitment to replacing functionality*

During the implementation of SCMIS, replacing the functionality of some segments seems inevitable. Although many people may oppose this change, system administrator or senior manager should commit to it. In addition, you may be successful in replacing the traditional SCM system by SCMIT but some users become disappointed to feel that their functionality is taken away (Stavri and Ash 2003).

5.3.13 *Lack of effective techniques for real-time planning, execution, and control*

These techniques include the simulation of alternatives to support the short-cycle pull of material through the supply chain.

5.3.14 *Enormous risk of not keeping pace in the marketplace*

Complicating the challenge is the enormous risk of not keeping pace in the marketplace, which can result in driving your customers into the waiting, open arms of your more aggressive competitors. The impact of a lost customer on revenue and profit are compounded by the costs a company will incur to recapture or replace lost customers (Soroor 2005).

5.4 *Listing CFFs within SCMIS*

Together with what we covered in the previous section, we totally recognised 49 CFFs as the causes of failure within SCMIS (Clarke 1999, Falk and Hogström 2001, Ghosh *et al.* 2001, Bolstorff 2003, Harrison *et al.* 2003, Stadtler 2004, Geunes 2005, Lambert 2005, Tarokh and Soroor 2005, Soroor and Tarokh 2006b, Sung 2006, Shirazi and Soroor 2007, Shemshadi *et al.* 2008). They are listed in Table 3.

5.5 *Critical failure factors pertaining to SCMIS environment*

Our studies have shown that the environment in which SCMIS is implemented has a remarkable impact on how the system will operate in future. Some of the CFFs relating to the characteristics of system's environment are presented in Table 4.

6. Discussion

Many further practical cases, not mentioned in this article, validated that this study has clearly supported the importance of CFFs for SCMIS success. The failure cases are so drastic in their failure that one might suggest they had been meant to fail. Apparently, there may be forces in the organisations that want the SCMIS to fail, and pursue this goal in a very systematic way.

Thus, a system that can clearly demonstrate benefits, by being linked to business objectives, will have a strong selling point with respect to user acceptance. Reflecting on

Table 3. Forty nine critical failure factors within SCMIS.

- Minor bugs not acknowledged.
- Not proactive enough predicting future supply channel status.
- Low turnover, too many choices, too intricate.
- Too much data input and output.
- Inadequate system response time.
- Problems with applications in time sensitive environment.
- Inappropriate payment methods.
- Vague transaction processing methods.
- Too many communication channels.
- Unavailability of resources (human, financial, technical, etc.).
- Inadaptability of various SCMISs.
- Mismatch of SCMIS with organisation's management system.
- Information security problems.
- Lack of well-defined supply chain process operational responsibilities.
- Supply chain operates on 'push' technology rather based on 'pull' to actual demand.
- Lack of streamlining information and material flows.
- Lack of strategic supply chain alliance agreements.
- Improper distribution planning.
- No trend toward development of SCM to a core competency level.
- Not setting the right priorities.
- Allocating inappropriate resources.
- Not recognising the system complexity.
- Misallocated resources.
- Inadequate training of users.
- Difficulty of taking all partnerships into account.
- Impossibility of supply chain real-time coordination.
- Inappropriate SCMIS staff.
- Inappropriate technology.
- Ill management of data.
- Lack of clear link to business objectives.
- Ill management of organisational resistance.
- Ill management of system evolution and spread.
- Lack of an evolutionary development methodology.
- Lack of carefully defined information and system requirements.
- Ill management of change.
- Weakness of decision making process.
- High implementation and maintenance costs.
- Insufficient commitment to replacing functionality.
- Lack of effective techniques for real-time planning, execution and control.
- Enormous risk of not keeping pace in the marketplace.
- Lack of developing and sustaining capabilities.
- Reduction of team interactions.
- Lack of risk management.
- Lack contingency planning.
- Weak budget control.
- Exceeding the project deadlines.
- Lack of identifying and focus on market.
- Adopting incorrect strategy.
- Lack of information privacy and information sharing problems.

Table 4. Environmental SCMIS critical failure factors.

- Unstable environmental situation.
- Different economies and politics.
- Lack of smart people in key positions.
- Lack of good system administrator.
- State of no one accountable.
- Little utilisation of system by related organisations and people.
- Hardware problems.
- Not enough trust in internal and external relationships.
- Inefficient supply channel partners.
- Cross-functional barriers to high velocity information and material flows.
- Dissatisfaction of supply channel members with SCMIS.
- Not clearly understood the strengths and weaknesses of current supply chain sub-processes.
- Organisation has not developed action plans for improvement.
- Lack of perfect business strategic plans.

the factors, we might also suggest a temporal consideration. Even before a SCMIS development is launched, it will require strong sponsorship to result in its initiation and seed resources. However, as the implementation continues, operational factors, such as resource availability (people, technology, and money) become a necessary condition. And finally, as the system moves into its use phase, while continued executive sponsorship and resources are required, a system will receive little use if it cannot establish clear benefits.

Direct supervision of work and personal reporting relations are more important forms of control. Therefore, the top management prefers to receive data through informal personal reporting rather than through an information system. On the other hand, support staff members may want to maintain their influence by providing critical data for the top management. Therefore, they are unwilling to change, fearing loss of influence once top management would be able to circumvent them by accessing SCMIS. Hence, it is no surprise that the staff are unwilling to supply data for the system.

Besides, the data providers and middle management may not cooperate with the SCMIS project manager. IT managers may observe that the corporate culture is not ready for the system's development (Tarokh and Soroor 2005).

Some management aspects of SCMIS, which might not be based on formal written rules, but on people's experiences and beliefs of what it takes to get ahead in the organisation, may be opposed to business objectives. Consequently, if strong enough, SCMIS may cause initiatives to fail by delaying them, or denying them some of their benefits that otherwise could have been beneficial for the business (Shapiro 1996).

Mismatch of the supply chain management information system with the organisation's management system should also be differentiated from 'normal' organisation resistance, which might be considered a generic fear of the unknown, or the 'fear-based culture'. In some cases, it seems that there exists an interest in letting the system fail rather than a lack of interest in system success.

7. Conclusions

The IT/IS industry and community continue to be plagued with extensive problems of systems failure. The field of IT/IS project management remains in 'chaos'. The gap

between theory and practice in SCMISs studies, particularly failure studies, remains. This paper is a great attempt trying to make sense of the somewhat 'confused' field of SCMIS project development and implementation. The emphasis is on the undesirable aspect of this gamble: 'Failure'. In order to enjoy the game, the supply channel manager has to prevent any sign of bad operation from converting into failure. By surveying a lot of previous works on information systems, supply chain management, business information systems, and related failure and success factors, the authors have introduced the critical failure factors in SCM, during SCMIS development phase, and within SCMIS itself. The tentative outcome of this study is a sorted collection of CFFs that is useful for every manager and executive of diverse organisations all over the world. This paper highlights the importance of restructuring the factors which play an important role in SCMISs and disregarding them has led the system towards failure.

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