International Journal of Mechanical, Industrial and Aerospace Sciences
ISSN: 2517-9950
Vol:1, No:8, 2007

Information System Life Cycle: Applications in Construction and Manufacturing

Carlos J. Costa and Manuela Aparício

***Abstract*—**In this paper, we present the information life cycle, and analyze the importance of managing the corporate application portfolio across this life cycle. The approach presented here does not correspond just to the extension of the traditional information system development life cycle. This approach is based in the generic life cycle employed in other contexts like manufacturing or marketing. In this paper it is proposed a model of an information system life cycle, supported in the assumption that a system has a limited life. But, this limited life may be extended. This model is also applied in several cases; being reported here two examples of the framework application in a construction enterprise, and in a manufacturing enterprise.

***Keywords*—**Information systems/technology, information systems life cycle, organization engineering, information economics

I. Introduction

AS pointed by Underwood, L. [18] Information Technology plays an important role in manufacturing firms. Nevertheless, the success of this integration depends on how Information Technology and Information Systems are managed.

The purpose of this paper is presenting a framework based in the information system life cycle that could be effective to analyze information systems and information technology adopted by a specific enterprise. Although we admit that this framework could be used in other contexts, our purpose is analyzing its effectiveness in corporations whose business is in manufacturing and construction industries.

Since Richard Canning´s seminal work [3], life cycle is presented as an approach to describe developing system process. This information system life cycle is composed of a sequence of phases, beginning with requirement analysis and ending with implementation. Then, several variations to this process are considered, waterfall life cycle ([2][5]) and spiral life cycle [1] are just some examples. In order to improve this process, some researchers incorporated prototyping [13], RAD - Rapid Application Development [11], JAD - Join Application Development [19] or PD - Participatory Design ([4][9]). This approach is extended and decomposed in several processes [15]. Even this approach is restricted to the development phase. A similar life cycle is used in the customization and installation of systems already developed, like CRM or ERP (e.g. [16]) or to specific environment like Web (e.g. [6]). But although emphasizing in an important phase, the development process is just one phase of the information system life cycle. What are the other phases? What are the main aspects to be considered in each phase of the processes? How to manage each phase?

In the following section, a new information system life cycle is briefly described. This information system life cycle was then extended according to four strategies. Those strategies are presented in section three. In section four, two cases, corresponding to the employ of this approach to analyze a real situation, are described.

Manuscript received July 4, 2005. This work was supported in part by the Portuguese Foundation for Science and Technology - FCCN.

Carlos J. Costa, Ph.D. is with the ADETTI/ISCTE He is also with the Department of Information Sciences end Technologies of ISCTE, Lisboa, Portugal (e-mail: carlos.costa@ iscte.pt).

Manuela Aparicio, MSc. is with LusoCredito, Lisboa, Portugal. (e-mail: manuela@lusocredito.com).

II. A Life Cycle for an Information System

Based in an approach developed by [5], we identified the generic process of a generic life cycle: baby, youth, adult and senior. If we compare it with an information system life cycle (or more correctly an information system development life cycle) it is centered in the baby and youth phase. On the other hand, experience and case analysis shows that information systems became senior, legacy systems and die. According to this assumption, sounds reasonable to redesign the system life cycle in the following phases [5]: Baby/Launching, Youth/spreading or growing, Adult/maturity and Senior/Declining.

Launch is a phase where technologies and general needs are identified. New solutions and technologies are also proposed. The argumentation is based on technical, operational, organizational and economical assumptions [14]. In this phase, it also takes place, analysis, design and implementation, which correspond to the traditional information system development process. It starts with requirement analysis and ends with implementation or installation.

Spreading is the part of the cycle process in which a desirable spreading of the system starts, as a result of an adequate implementation

Maturity is a phase that is partially covered by the maintenance. In this phase, it is especially important maintaining the applications, supporting the users, and

auditing the system. The existence of rules to standardize this process generally contributes to the improvement of the performance of the system and people that use it.

Decline is the last phase of the system. In this phase, the system is being transformed in a legacy system that must be converted.

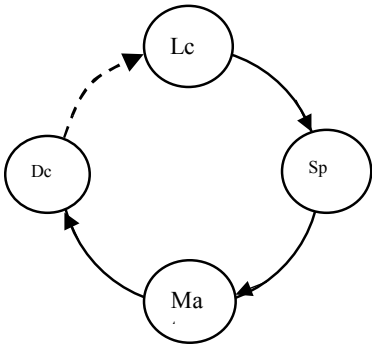


Fig. 1 A "basic" Information System Life Cycle

In the following table, each one of the phases is analyzed in what concerns the technology, operation and costs.

TABLE I
ROLES VERSUS TECHNOLOGICAL, OPERATIONAL AND ECONOMICAL DIMENSIONS

	Technology	Operation	Costs
Launch	Identify technologies that may answer to strategies Obtain in deep knowledge of the technology adopted	Identify strategies Motivate future sponsors of the systems. Identify the needs and focusing in the implementation of the system and not in marginal items.	Look into expenses and all its dimensions, like investments, maintenance costs or training. Control costs, quality and execution time
Spreading	First signs of good integration of the system with other subsystems	Good services and maintenance in order to contribute to high productivity in the organization. Make other employees productive	. In this phase costs are still high in order to expand and contribute the maximum productivity.
Maturity	Still adequate integration of system with the operations of the organization.	The maximization of the benefits has been achieved and there is a balance between the contribution of the system and the efforts done to make the implementation happen.	Reduce costs. Emphasis in the maintenance and service agreements. Analyze carefully trade-off between do and buy.
Decline	Identify applications, technologies, software and hardware compatible with the technologies used by the organization.	Train and educate users to the change.	Tries to profit from the legacy system. Try to move to new applications.

This approach gives special importance to the technical and operational dimensions.

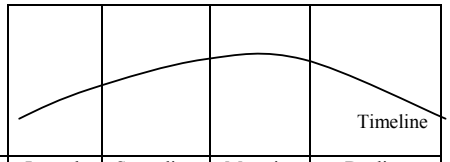
The technical (or technological) perspective is the first dimension to be considered, as long as, information systems and corresponding applications depend on the evolution of the information technologies. The technological evolution pushes the use of new applications, new hardware or new software.

But, other dimension is the operational dimension. In fact, the users are also important drivers to the use of new technologies. But the economical dimension is also significant in the introduction, implementation, and management of new applications.

Often, the information technologies managers only may manipulate directly the costs. Benefits depend mainly from the impact on the operations and in the organization.

In other words, as in any other asset, it only contributes to the production, if it is implemented, integrated and used in order to maximize benefits and reduce the cost of production factors.

An analogy with the BCG (Boston Consulting Group) Matrix [8] and the proposed information system life cycle, could be made, as shown in **Fig. 2**



Inf. System Life Cycle Phase	Launch	Spreading	Maturity	Decline
BCG Matrix Quadrant				
Market Growing Perspective	Good	Good	Not Good	Bad
Related Market Share	Low	High	High	Very Low
Required Resources	Great amount	Great amount	Few	Few
Benefits/	Low	High	High	Loss

Fig. 2 Relation Between Information System Life Cycle and BCG Matrix

In each phase there are some specific sceneries:

- Launching: this phase, is characterized by uncertainty of the acceptance, this is the reason why the BGC named it a "Question Mark". The acceptance of the system is still a dilemma, because an organization requires guaranties and continuity, in order to change

into a new system. In this first phase the cost/benefit ratio is not superb, because as in any other investment, it takes some time to achieve benefits from a system. In most cases there are good perspectives of a growing market, the market share is still small and it is required a great amount of resources and the benefits are low, in this first phase.

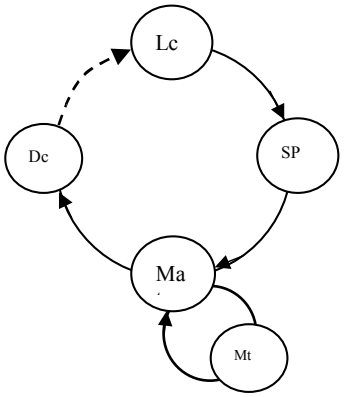
- Spreading: this is the second phase, which is characterized by the expansion, because of the diffusion of the system, by other parts of the organization or by other organizations, that is why the Boston Consulting Group called the star, it is the best phase of the cycle, when everything shines; good perspectives about the market (growing, a bigger share than in the previous phase). Although it should require a great effort for supplying the needed resources, they are overtaken by the benefits.
- The maturity phase, is achieved when there are no perspectives of a growing market, but on the other hand there much more benefits than costs, because by then the system is getting its best performance, maximizing benefits, minimizing the costs to produce those benefits.
- The last phase is the decline, when there are more costs than benefits. It may even occur in losses rather than in benefits. The market is growing no longer and the share is so small that BCG called the dog quadrant. If a system goes thru all these phases, than afterwards the cycle is closed.

III. EXTENDING THE "BASIC" INFORMATION SYSTEMS' LIFE CYCLE

The basic information system life cycle is composed of four phases: Launching, Spreading, Maturity and Decline. What happens when a system die? A system must be replaced or renovated? How to manage the decline in the information system life cycle? We may identify four strategies:

- Perpetuate system,
- Manage transition
- Prepare heir
- Manage strategically

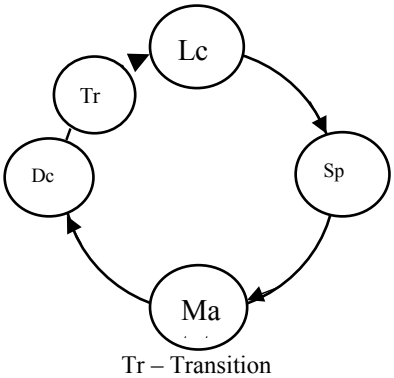
In order to enlarge an information system life cycle one of the most common strategies is perpetuating the actual system (Figure 2). This is almost impossible, but an intelligent use of maintenance may contribute to extending the life of an information system. This in fact is a lesson, learned already for years in manufacturing industries [20].



Mt – Maintenance
Fig. 3 Perpetuate system

It is also important identifying exactly the boundaries of the information system analyzed. For example, the system may be dependent from infrastructure technology (e.g. operation system, database system). The change to a new version of the operation system may contribute to an adjustment in the system.

When it is impossible to perpetuate an information system, it is fundamental to manage the changing process. The management of change is generally subject of reaction and the success of this transition is fundamental to the success of the "new" system [10].



Tr – Transition
Fig. 4 Manage transition

The transition process may consist in a parallel process. In this process the old system may still being used while a new system is launched (Fig. 5). This strategy might be prudent, because when the new system is launching, is also gaining some bases in order to turn the change more secure and smooth.

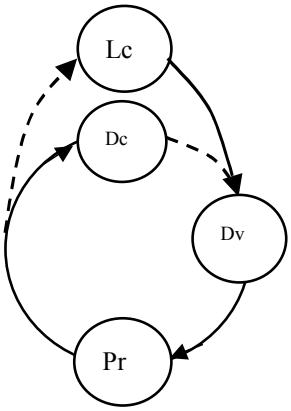
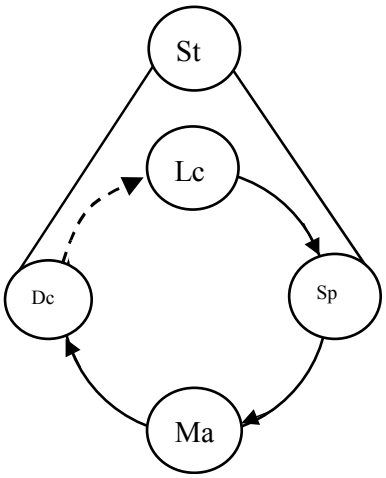


Fig. 5 Prepare heir

Other perspective consists of managing strategically the whole system. This perspective is different from managing a portfolio of applications [12], as long as, what are being analyzed here are families (or "dynasties") of information systems. Most of the times, they act like upgrades of the old system, instead of being a totally new system. It can be called as relaunch before the decline.



St – Strategy

Fig. 6 Manage strategically

An organization may implement one of several of those strategies. But it is possible using the framework developed in this and in the last section for typifying the IT strategies implemented? This question will be answered in the next section. It seems to be no better strategy than other. What can be said is that a strategy is sometimes more adequate than other, depending on the situation. For instance if the system is totally far away of the real needs then, the strategy that is more adequated, is the transition. But, if there are mere functionalities that may be incorporated, than it should be chosen, the prepare heir strategy.

TABLE II
TRANSITIONS AND ORGANIZATIONAL CONSEQUENCES

	Mt	Tr	Ph
Core Business System	X		X
Need to be improved	X		X
The needs are not fulfilled		X	
Not the Core Business		X	X

One might say that there is no better or absolute strategy, but it can be adequated or not to the company situation.

IV. TWO CASES

In order to analyze in what extent described models actually are adopted by organizations, we analyzed several situations. In this section, we report two examples corresponding to studies developed in two enterprises. One is a construction corporation, while the other is an enterprise in the chemical industry, specialized in the manufacturing of cleaning products.

A. Case 1: Construction Enterprise

The building construction enterprise is established for more than 20 years and now is concluding a large real state project.

We performed an inventory of the main hardware and software systems as well as its corresponding information systems. Information Systems and information technologies employed may be grouped in several areas. But here we are present only those that support engineering, architecture and production, as well as infrastructure, mainly Office systems and CAD support engineering. There are also some specific engineering programs, but in fact engineers do not use them, as long as structure engineering is outsourced. On the other hand, Office systems are widely used for reporting and decision support.

There is an effort with the purpose of using Linux infrastructure. But there are some reactions, especially from CAD users and also from accounting system (not reported here).

An information system is also being used to control plant access. This system is composed of a component that is related to the gate control, allowing the registration of all the employees that access to the plant by using their individual card. This information is sent to the plant manager and to operation management and accounting. The plant manager may control all the people that are in the plant and identify if there is any intruder. The operational manager uses also this information to support his decision concerning contractors' management and employees' management. Accounting, in order to produce productivity reports and also to support wage process, also uses this data. This system is used either for legal purposes, either for controlling productivity. The interface with all the other systems is limited.

TABLE III
SYSTEMS ACCORDING TO EACH INFORMATION SYSTEMS LIFE CYCLE PHASE IN A CONSTRUCTION CORPORATION

Phases	Office System (Open Office/ Microsoft)	CAD	Infrastructure (Linux)	Plan Access Control
Launch	Open Office / launch - experience		Linux	
Spreading				
Maturity	MS-office	AutoDesk CAD	Windows XP	Access Control
Decline	MS-office / decline old version is being used		Windows 2000 Windows 98	

It is expected a strong reduction in the production activity. Consequently, it is expected that they will reduce investment, mainly in information technology supporting production and operation activities.

B. Case: Chemical Enterprise

The other enterprise being analyzed is a small enterprise that produces mainly cleaning products. The enterprise has more that 30 years, but has faced several difficulties in its computerization process. In fact, implementation of information systems in the area of logistics and inventory control failed several times.

Here, several problems were detected:

- Production process is considered confidential and one of the most important competitive advantage.
- This enterprise is subject of a very turbulent competition.
- Large international corporations dominate industry.
- According to the owners of the firm, the use of new technologies in the production does not seem to contribute to improve competitive capacity.

Now, it is being launched the implementation of a system that supports logistics, inventory and commercial areas.

TABLE IV
SYSTEMS ACCORDING TO EACH INFORMATION SYSTEMS LIFE CYCLE PHASE IN A SMALL CHEMICAL ENTERPRISE

Phases	Logistics	Inventory/ Commercial	Infrastructure (Linux)
Launch	Web	Sage	
Spreading			
Maturity			Windows XP
Decline			Windows 2000 Windows 98

As long as production is becoming dependent from international corporations, only in commercial area is possible obtaining competitive advantages.

As consequence of production process secrecy, the automation of production is not developed. Consequently, the use of information technologies to monitoring purposes is also difficult to implement as consequence of production technologies used.

In conclusion, the diagnosis of this enterprise showed a situation that is far from a "post-industrial manufacturing" model [17].

V. Discussion

The use of this framework proved to be effective to analyze information systems and information technologies in the context of enterprises of construction and manufacturing. Nevertheless, it was not possible to identify what model was the most used.

It was also possible to foresee that those models should be related to the manufacturing strategies. In fact, if an emprise is going to reduce its activity, what happened with the construction firm, it is expected that this fact will affect IT/IS strategy.

VI. Conclusion

In this paper we presented an approach based in the generic life cycle. This information system life cycle is composed of the following phases: Launch, Spreading, Maturity and Decline. It is proposed a model supported in the assumption that a system has a limited life. The main characteristics of each phase were identified. On the other hand, a limited life may be replicated, extended or integrated in a strategy, whose main purpose may consist of perpetuating systems, managing transition, prepare a heir or manage strategically. This framework was then used to analyze information technology infrastructure of two enterprises.

From examples presented, it was verified that information systems and information technology strategy should be related to the manufacturing strategy and also with the business strategy.

References

[1] B. Boehm, "A spiral model of software development and enhancement"; *Computer*, May 1988.
[2] B. Boehm, *Software engineering Economics*, prentice-Hall, Englewood Cliffs, NJ, 1981
[3] R. Canning, *Electronic Date Processing for Business and Industry*, John Wiley & Sons, N. Y., 1956.
[4] E. Carmel, R. Whitaker and J. George, "PD and Joint application Design: a transatlantic Comparison", *Communication of the ACM*, June 1993, Vol. 36, No.4.
[5] C. Costa. "Information system life cycle and management roles". In P. Isaías, N. Karmakar, L. Rodrigues, P. Barbosa (Eds.) *Proceedings of the IADIS International Conference WWW/Internet 2004*, Madrid, Spain, Volume II., pp1170-1174
[6] C. Costa and M. Aparicio "Developing Small Web Based Systems" *WSEAS Transactions on Computers*, Issue 3 Volume 3, July 2004, pp. 647-652
[7] N. Enger, "Classical and Structured Systems Life Cycle Phases and Documentation" in Cotterman, W., Conger, J, Enger, N. Harold, F. (Ed) *System Analysis and Design: A foundation to the 1980s*, Elsevier North Holland, NY, 1981.

[8] A. Gerald, "A note on the Boston Consulting Group Concept of Competitive Analysis and Corporate Strategy", Intercollegiate case Clearing House, 9June 1976
[9] F Kensing, and A Munk-Madsen "PD: Structure in the toolbox", *Communication of the ACM*, Jun 1993, Vol. 36, No. 4, pp 78-84.
[10] W. Kettinger, J. Teng, and S. Guha, "Business Process Change: A strategy of methodologies, techniques and Tools", *MIS Quarterly*, March 1997.
[11] J. Martin, Rapid Application Development, MacMillan, NY, 1991.
[12] F. McFalan, "Information Technology changes the way you compete" *Harvard Business Review*, May-June, 1984, pp 98-103.
[13] J. Naumann, and A. Jenkins "Prototyping: the new paradigm for systems development", *MIS Quaterly*, 6 – 3, September 1982, pp. 29-44.
[14] J. O'Brien, *Management Information System – Managing Information Technology in the Business Enterprise*, 6th Edition, McGraw-Hill, 2004.
[15] Rational. *Rational Unified Process, Best Practices for Software Development Teams*. A Whitepaper, 1998.
[16] SAP, ASAP91 – *SAP Implementation, R/3 System, Release 4.6C*, Material Number 50045234, June 2001
[17] R. Jaikumar, "Post-Industrial manufacturing". *Harvard Business Review*, November -. December, 1986.
[18] L. Underwood, Intelligent Manufacturing, Addison Wesley, 1993
[19] J. Wood and D. Silver, *Joint Application Design*. New York: John Wiley & Sons, 1989.
[20] R. Lamb, *Availability Engineering and Management for Manufacturing Plant Performance*, Englewood Cliffs, Prentice Hall, 1995

Carlos J. Costa, has a Ph.D. in Information Systems and Data Bases.
He is with the ADETTI/ISCTE and also with the Department of Information Sciences and Technologies of ISCTE, Lisboa, Portugal (e-mail: carlos.costa@ iscte.pt).

Manuela Aparicio, is economist and accountant and has MSc. in Information and Digital Library Studies. She is with LusoCredito, Lisboa, Portugal. e-mail: manuela@lusocredito.com).