Assessing information systems practices in manufacturing SMEs

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Abstract

This paper presents the preliminary results of a survey carried out on a sample of 30 manufacturing SMEs in Northern Italy. The research focuses on the assessment of the Information System (IS) currently implemented in the considered organizations and aims at identifying strengths, weaknesses or inconsistencies, obtaining useful information in order to address new IT investment and to improve user satisfaction and corporate performance.

With this paper we investigated the relations among IT expenditure, how the information system supports activities, and the deriving level of user satisfaction. The links among these aspects were examined subject to various endogenous and exogenous factors, such as corporate IT culture, business dimension, control structure, market approach and so on.

Empirical results seem to support a direct link among IT expenditure (more specifically running expenses) and the amount of activities supported by the IS, and show a strong relation among the support of relevant activities by means of the IS and user satisfaction. Various endogenous and exogenous factors were found as relevant antecedents of corporate expenditure.

Keywords: Information systems, check-up methodology, small and medium enterprises.

1. Introduction

Evidence has been cast by many studies (for instance, Kraemer & Dedrick [1] or Tam [2]) on the existence of a relation among ICT investments and economic development of a country. Likewise, Siegel and Grillriches [3], Berndt and Morrison [4] and Lehr and Lichtemberg [5] report about a relation between IT investment and economic results at industry level. Thus, IT investment can be regarded as a major driver of economic growth at a macro-economic level.

Yet, this relation is harder to show at a micro-economic level and for single firms, even if some authors claim they did, like Radhakrishnan *et al.* [6], who report about some more studies on this topic. Nevertheless, at least from a qualitative point of view, IT is considered by experts a fundamental management lever at the corporate level as well. For instance, an international panel of more than 1.000 researchers, consultants and managers (Montorio and Taisch) [7] identified a set of IT tools as key enablers to develop customized and technologically complex products by largely networked companies which collaborate and compete the ones with each other.

Exactly for these reasons, many manufacturing SMEs are currently facing a very serious competency gap in keeping up with the above discussed challenge of remaining competitive. A report from the United States Department of Commerce [8] claimed that overall manufacturing SME's productivity was growing at one half the rate of larger manufacturing companies in connection with IT underinvestment: this might happen outside USA as well, and especially in developed countries with a lower level of ICT literacy, like Italy. For instance, Irani *et al.* [9], argue that many (especially small or medium) companies find themselves increasingly unable to assess the full implications of their ICT investments. Donovan [10] further reports that almost 90% of companies that implement ERP systems are not successful or at least only partially successful at the first attempt.

Given the above drafted scenario, this empirical study investigates the relations among users' satisfaction with their Information System (IS), the type and number of activities supported by

the IS, and corporate IS expenditure. More specifically we referred to the three following research questions:

i).   which are the main antecedents or enablers of IT expenditure, and how they affect the way resources are allocated to either IT investment or running expenses?

ii).   Is there any connection among the amounts spent on IT (either on investment or current expense) and how the IS supports users' activities?

iii). Finally, is there any link among how much users are satisfied with their activities, and the level of support they get from IS?

In order to answer to these questions, chapter 2 presents this research's conceptual background; chapter 3 its methodological framework; the empirical evidences generated are illustrated in chapter 4 and the conclusions stemming from them are discussed in chapter 5.

2. Background

Various authors agree on the ability of Information Technology (IT) to jointly foster both efficiency and effectiveness at an operational as well as corporate level. More specifically, according to Radhakrishnan *et al.* [6], IT can have three types of impact on operational processes: to *automate* (with the effect to perform the same tasks more efficiently), to *informate* (with the effect to improve the set of information used to take decisions), and to *transform* operational processes (with the effect of enabling collaboration at the interface between actors of a supply chain). For instance, Shin [22] shows that the usage of IT according to corporate strategy can improve a firm's gross margin, by enabling a more efficient coordination of multiple business resources across many and diversified markets. Yet, there is a second and less intuitive mechanism through which a savy investment in information technology can add value to a firm: by increasing its assets, especially the intangible ones, through a more formalized portfolio of internal, firm-specific and hard-to-copy competencies and information, as supported by Wu *et al.* [24], and Real et al. [23].

Yet, in the last years, several studies ([11], [12], [13], [15], [16], [17]) analyzed IT strategies and practices in SMEs, the variables influencing them and the benefits achieved, discovering that more often than not the IT outlook in small concerns is less brilliant in practice than it might look in theory. A first reason implying the limited success of IT investments in small companies is the endogenous context, and in particular the lack of sufficient financial resources and organizational culture [12]. Corporate culture can also be seen through the presence of a quality assurance system [11] and the level of employee qualification [14].

One way corporate culture can practically help in the decisional process underpinning IT expenditure, is by formulating a thorough IT strategy and planning. According to Levy *et al.* [15] IT strategy can play a critical part in helping organizations to increase efficiency, effectiveness and competitiveness. Blili and Raymond [16] show that IS planning becomes more critical as IT becomes more central to products and processes and that consistently IT planning needs to be integrated with business strategy. Yet, few SMEs plan their IS (Hagmann and McCahon, [18]), while the limited planning that is undertaken tends to focus on operational systems to improve efficiency and effectiveness, and there is little concern with competitiveness. One reason for SMEs' limited view of planning is that most invest in IS incrementally (Hashmi and Cuddy, [19]) usually in response to a sequence of specific needs, particularly to improve basic administration and transaction processing.

The last two remarks both point to the fact that SMEs tend to concentrate too much on the efficiency effect of automating processes through IT and therefore lose the opportunity of achieving other equally relevant advantages, such as the "informate" and "transform" effects mentioned by Radhakrishnan *et al.* [6]. Hagman and McCahon [18] for instance, find that US

SMEs tend to consider IT as a mean for obtaining greater efficiency in their internal organization, but that it is not used as a mean to increase external competitiveness.

This practical trend is in contrast with the conceptual results of Blili and Raymond [16], who recognize the need for SMEs to use IT as a mean of integration within their supply chains; the role of IT in cost reduction is only recognized in addition to this more strategic objective. They also show that investment in IS is a strategic decision, largely because it involves a heavy financial burden. Existing strategic models in their opinion can be useful, as Levy *et al.* [15] provide evidence for.

3. Methodology

The empirical results illustrated in this paper belong to a wider research project centered on the IT usage in Italian SMEs and performed by INF-OS, the Center of Competence on process innovation in Operations. Within the same research, financed by Lombardy region's INGENIO program, funded by the EU, Pirola *et al.* [17] presented the "check-up" methodology to asses information systems in SMEs. Within the check-up scheme, information was gathered as illustrated by Table 1.

Category	Information collected
Context	Industrial sector, dimension, control structure, supply chain positioning, education levels; insourcing – outsourcing of main activities; products; processes; market; customers.
ICT culture	Perceived relevance of information systems; Main results achieved; Main barriers perceived to ICT; evaluation of personal ICT competence
EDP service	Insourcing – outsourcing of main EDP activities; EDP position within the organization; dimension of the EDP team; education level; skills; main activities performed;
Information System	Architecture and platform; Main general purpose functionalities; Number and type of points of access; Mobility and connection; number of users by function;
ICT spending	Investment and current spending in ICT in last 3 years subdivided by activities and resources.
Activities supported	For each of a list of activities: level of relevance; level of application; level and type of IT support; level of users satisfaction for IT support.
ICT applications	For each application: level of integration with other applications and level of customization
ICT projects	For the last large IT project undergone: time and methodology employed for software and vendor selection; time and cost supported; Objectives pursued; level of project management formalization; level of time and cost budget fulfillment; next areas of investment;

Table 1. List of the main data collected within the research program

Given the large amount of information to collect at each company, we resorted to a case study research. Each case was developed through a set of semi-structured interviews, each carried out with a well-defined manager at each single company. More specifically, 9 different interviews of 4 different types were carried out at each company, namely with: the CEO, the administration manager, the IT manager and a set of relevant functional managers, encompassing: sales, purchasing, manufacturing, logistics, quality and R&D. The main information categories highlighted in table 1 were collected from each manager as described in table 2.

Each interview was prepared by sending to the connected person the relevant list of questions, so that the involved data could be collected in advance. Moreover, a telephone support was provided before and after the interview in order to care for missing data or misinterpreted

questions. Answers were coded within a MS ACCESS © database directly in front of the interviewees.

Category	CEO	Administration manager	IT Manager	Functional Managers
Context	X	X	X	X
ICT culture	X	X	X	X
EDP service	X		X	
Information System			X	
ICT spending		X		
Activities supported	X	X	X	X
ICT applications			X	
ICT projects			X	

Table 2. Pattern of data collection among managers interviewed

After collecting data, information was elaborated both automatically and manually to let the main evidences of each case study performed emerge on top of the vast amount of data collected. Analyses performed belong to both descriptive and inferential statistics: confrontations and comparisons were made both among different companies in the research sample and within each single company.

More in detail, analyses among companies were carried out in order to compare single aspects between each company and a "control group" of firms that were considered similar to it in dimensions, control structure, type of produced goods, product's structural complexity, and market orientation. We deliberately decided not to take into consideration the specific branch of industry as a comparison factor, due to the fact that it would have reduced too much the size of each cluster. Each firm was compared with its control group's average and best practice company in order to find out its strengths and weaknesses.

Moreover, analyses within each company were aimed at pointing out the main areas of inconsistency.

After performing a pervasive analysis of data collected at each single company along the above drafted guidelines, we reverted to interviewed companies and held a workshop during which the main evidences collected were presented and discussed in depth: in some cases, some of them and some of the undergoing data had to be updated as a consequence of discussions held during the follow-up workshop.

Around 100 SMEs were contacted in Brescia and Bergamo provinces in Northern Italy, in order to take part to this research program: the list was provided by the local entrepreneurs associations and they were chosen in order to match the prevailing sectors within those provinces. 30 companies accepted and were actually involved.

4. Empirical evidences

In order to answer to the research questions posted in chapter 1 of this paper, we investigated the relations among users' satisfaction with how the IS supports their activities; the type and number of activities supported by the IS, and the corporate IS expenditure. The underlying conceptual model hypothesizes that, the more the expense, the more functionalities can be

supported, and thus the more the users' satisfaction with the system. All of these three aspects were investigated with relation to a set of internal and external context factors, in order to assess the enabling or inhibiting influence they can play.

4.1. Context factors

In order to identify the conditions that most enable or inhibit IT spending, we considered a set of endogenous and exogenous context factors, that are described here below.

The first and only endogenous factor considered is corporate IS culture. We asked each corporate representative interviewed to rate how much he/she agreed with a set of statements regarding on the one side the costs and risks and on the other one the benefits connected with IT. Table 3 reports how the sample was clustered on this factor.

| | | % Agree with IT benefits | |
		Low	High
% agree with IT cost / risk	High	Skeptical (30%)	Aware (44%)
	Low	-	Enthusiastic (26%)

Table 3. Sample clusters regarding IT culture

In addition, we considered a set of exogenous factors, listed in table 4 here below.

Factor	Clusters
Dimension	Large: more than 250 employees (7%); Medium: 50 – 250 employees (63%); Small: less than 50 employees (30%)
Control structure	Controlled by a group (48%); independent (52%)
Produced goods	Durable consumer goods (15%); Industrial goods (48%); industrial components / subgroups (37%)
Products complexity	Simple: max 2 BOM levels and 20 components (38%) Intermediate: 2-5 BOM levels and 20-100 components (42%) Complex: 2+ BOM levels and 100+ components (20%)
Market orientation	Customer oriented: -500 customers and 30+ orders/customer (8%) Intermediate: -1.500 customers and -30 orders/customer (58%) Market oriented: 1.500+ customers and -30 orders/customer (34%)

Table 4. Sample clusters regarding external factors

4.2. IT expenditure

Information on IT expenditure was collected over the last 3 years (2004 – 2006) and grouped by nature (investment vs. running expenses) and resource (hardware, software, labor, external services, etc.).

The yearly trend of IS expenditure as a percentage of the corporate value added was compared through different clusters deriving from the endogenous and exogenous factors identified in § 4.1. Figure 1 presents the total yearly expenditure trend as a percentage of corporate value added. Only factors and clusters for which relevant sample differences were achieved are reported. The sample as a whole experienced in the considered time horizon a sharp IT expenditure versus value added increase, from 2,5% in 2004 to almost 3,5% in 2006: this shows that the attitude of investigated firms toward IT expenditure is, in average, improving. Moreover, running expenses (from 52% on total IT expenditure in in 2004 to 57% in 2006), and especially external services (from 11% on total IT expenditure in 2004 to 16% in 2006), are increasing more than investments, showing that a shift from the insourcing to the outsourcing of IT services is in course of action. Yet these trends are by no means general. In

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facts, corporate IT culture plays a major role in determining a firm's attitude towards allocating resources on IT: not only do skeptical companies allocate on IT less than half the resources as other companies, but they also show a decreasing trend from 2004 to 2006. The control structure, market orientation and type of manufactured products all play a statistically significant role in setting either the IT expenditure amount or its trend.
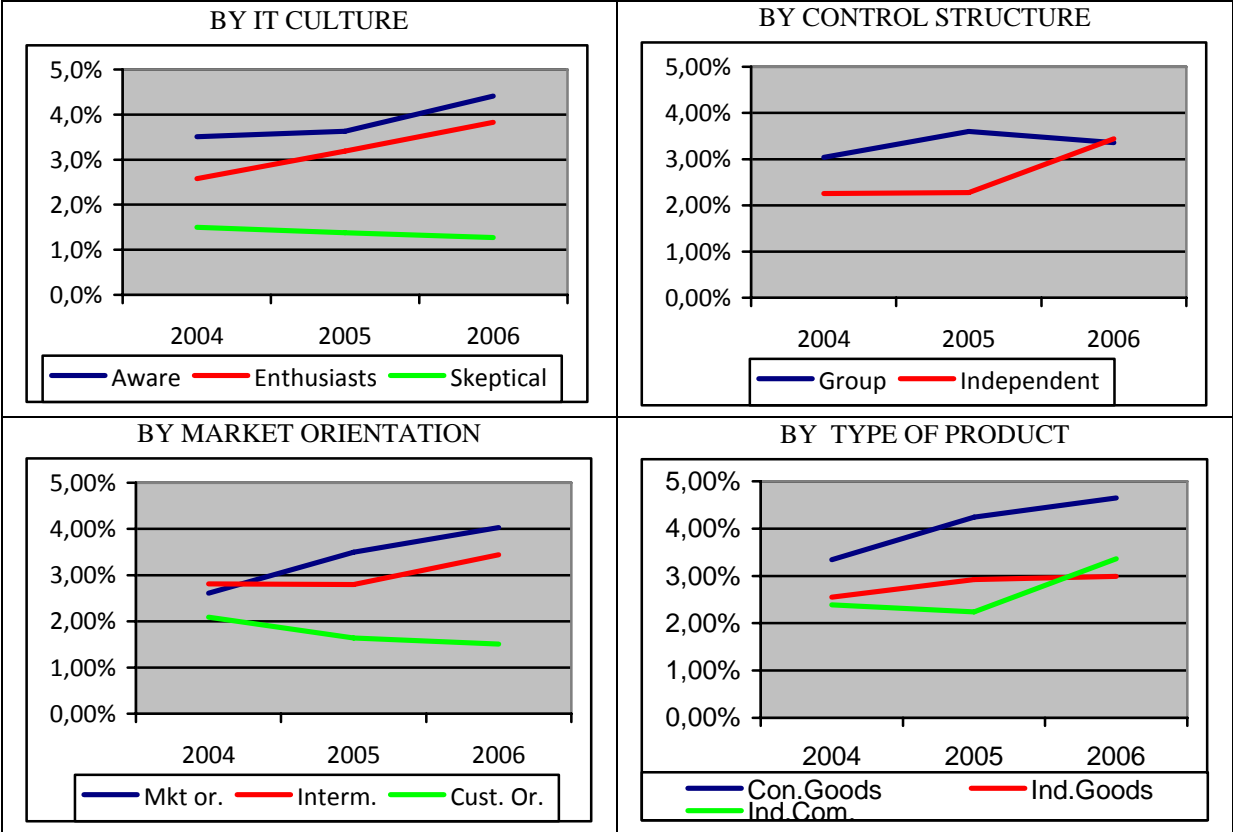

Figure 1 Total yearly IT expenditure trend as a percentage of value added

Following the above highlighted impacts on IT expenditure, each firm within the sample was categorized according with its IT expenditure and its balance among investment and running costs, as compared with the average of companies sharing its IT culture, control structure, market orientation and type of product cluster. Four different clusters of companies were derived, as presented in Table 5.

		IT Investment costs	
		Low	*High*
IT Running costs	*High*	User Oriented (12%)	Innovators (8%)
	Low	Lazy (68%)	System Oriented (12%)

Table 5. Sample division by IT expenditure allocation

Companies with an IT expenditure lower than their cluster's average in both investment and running costs were defined as "Lazy"; firms high on investments and low on running costs were named "System oriented", since they tend to spend more than average in improving the system with new IT projects rather than in improving users' support with the current system's

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configuration. Conversely, firms high on running costs and low in investments were labeled "User oriented", since they prefer a good level of users support with the existing system rather than investing in new IT projects. Finally, "Innovators" are firms showing both higher than average investment and running costs. More than two thirds of interviewed companies were lazy in IT spending, while less than 10% adopted the innovator profile.

4.3. Activities supported by the IS

We distinguished all the investigated activities into five different subsets, relating to their level of IS support, as follows:

i. the first group encompasses activities that are *supported* by the IS

ii. the second one considers activities that are not yet supported by the information system, but whose support is currently *in project* (either still on the blueprint, or in progress)

iii. the third one considers activities that are currently *not supported* by the IS and that are instead supported by another stand alone application, mainly pertaining to the office automation type, or not supported at all by any ICT application

iv. the fourth group encompasses activities that do not need a specific support given that they are *outsourced* to third parties

v. finally, the fifth group considers activities that are *not performed* by a the considered company, so that no support at all is needed.

Figure 2 illustrates the percentage of performed activities supported by the IS by corporate dimension. The displayed percentage was actually computed as the ratio of supported activities divided by supported + in project + not supported ones. The company size was the only endogenous or exogenous contextual factor to be found statistically connected to the percentage of activities supported by the IS.
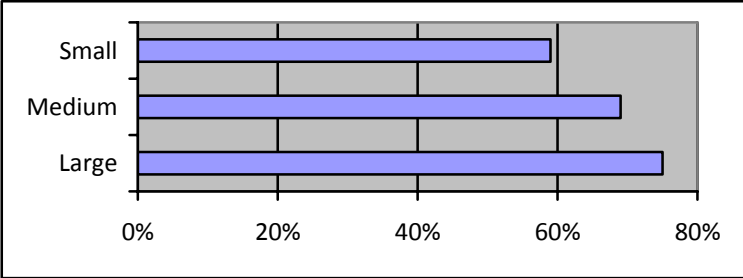

Figure 2. % of performed activities that are supported by the IS by corporate dimension

Table 6 examines the relation among supported activities and IT expenditure.

		IT Investment costs		
		Low	*High*	*Avg*
IT Running costs	*High*	User Oriented 69%	Innovators 73,3%	70,7%
	Low	Timid 67,1%	System Oriented 60,6%	66,1%
	Avg	67,4%	65,70%	

Table 6. % of performed activities that are supported by the IS by IT expenditure cluster

Companies belonging to the Innovators cluster tend to support by means of their IS more activities than companies belonging to any other IT expenditure cluster: so, a positive relation among IT expenditure and IS support of activities can be hypothesized. Yet, this relation is

actually there in the case of running costs, since the percentage of IS supported activities increases sharply when switching from low to high running costs spending companies. Quite the contrary a counterintuitive and less significant variation in the same percentage is achieved when switching from low to high investment costs.

4.4 Users satisfaction

Table 7 shows the average users' satisfaction by levels of IS support and activity perceived relevance. Data presented refer to the whole sample, but the same relation (even if with slightly different numerical values) can be achieved when considering any of investigated factors and related clusters.

		IS Support	
		Yes	*No*
Relevance	*High*	83%	34%
	Low	75%	74%
	Sample	80%	59%

Table 7. average users' satisfaction with their activities by levels of IS support and relevance

The average level of satisfaction connected to activities supported by a specific IS functionality is consistently and significantly higher than that of activities supported otherwise. Since the observed effect does not seem to be confined within a certain group of firms, of activities or managers, this allows to derive a strong suggestion on a generalized and positive relation among IS support and users' satisfaction. Yet, this positive relation can only be proved for activities rated by users as being relevant for their businesses, while it does not exists for less important activities.

5. Conclusions

This paper was written, as part of a wider research program, in order to investigate relations among: IT expenditure, how the information system supports activities, and the deriving level of user satisfaction.

Regarding IT expenditure, examined in section 4.1., empirical evidence highlighted an increasing trend on average in the last 3 years. This could be good news: yet this trend is far from being general. In facts, IT corporate culture, type of control structure, market orientation and the type of manufactured product were found to be all relevant factors in influencing both the level of corporate expenditure and its trend over time. This gives an answer to the first research question of this paper, regarding the enablers or antecedents of IT expenditure. Authors agree by and large on the notion that IT expenditure *per se* does not make immediate impacts on the firm performance. Ross and Ernstberger [20] build on this point, by showing through an empirical study that most efficient and highly productive manufacturers tend actually to spend less on IT than average manufacturers. So, the expenditure analysis performed in this study was rather functional to categorize companies by their level of IT expenditure and by how they balance resources allocated to IT among investment and running costs.

The percentage of investigated activities that is actually supported by a specific IS functionality was found to be rather high, at around 70% of activities performed within investigated firms on average. Yet, this percentage was found to depend strongly on corporate size, in that large companies tend to have a much larger percentage of their activities supported by the IS. Most importantly, it was found that also IT expenditure has a relevant

impact on the amount of supported activities, and that this effect is entirely connected to running expenses, rather than to investment. This empirical evidence answers to the second research question of this study, about the connection between expenditure and functional support of activities. Such a counterintuitive result might depend on the time dimension. System oriented firms could be in the process of investing strongly on new applications that have not yet delivered support to any activity; by contrast, user oriented firms are probably experiencing a higher level of running expenses together with a larger amount of supported activities exactly because they have already reached a steady state after a large IT investment in the past. The 3 years perspective considered in this study was intended to cope with this effect, consistently with the remark from Mahmood *et al.* [21], that pointed out that a two-year lag exists between the time of IT investments and the final firm performance; yet, it could have been too limited.

Finally, the users' satisfaction with activities performed was found to be strongly connected to whether activities are supported by the IS or not, suggesting a strong link among the scope of activities supported and users satisfaction with the IS. Moreover, this link does not exist for less relevant activities, while it is extremely evident for activities that users consider as relevant for the corporate business. This finding gives and answer to the third of this study's research questions, regarding the link among functional support and users' satisfaction and is perfectly in line with the claim from Radhakrishnan *et al.* [6] that in order to actually build a differential business value through IT, companies should identify critical organizational processes, and do all the necessary process changes *before* they install sophisticated new sw applications to support them.

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