Information Systems in Healthcare

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Current Issues and Future Trends

By

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INTRODUCTION

This book examines the topical issue of the role played by information systems (IS) in the field of healthcare.

In recent years debate has been sparked by an emphasis in the literature on the suggestion that a distinguishing feature of complex organizations, such as those involved in healthcare, is that certain conditions make it extremely difficult for them to establish a set of rational and integrated goals and objectives that can enhance the effectiveness of IS. Healthcare provides a well-known example of complex organizations, whose complexity influences the interaction of internal elements, the processes of change, and the results of the process itself.

An important feature of such complexity is the existence of dominant groups of professionals, such as physicians, who have been trained to perform their specialized tasks independently. Thus, possible role conflicts may emerge if healthcare professionals face controls and perceive IS to be a means of restricting their autonomy.

It is worth noting that the literature emphasizes that even if significant resources are devoted to the development of IS in this sector, several questions regarding the effectiveness of these systems remain unsolved. In fact, it has been argued that further concerns relating to the effectiveness of IS are due to the fact that only some aspects of performance can be measured, the tendency of processes to be less transparent and more difficult to evaluate, and the uncertainty related to the lack of commonly accepted indicators.

However, IS have great potential as they can totally re-shape the way performance in the field is designed, realized, and delivered with positive impact both in terms of quality and in the economic and financial dimensions.

This book first examines the potential of IS to shape change management processes in complex organizations. It then addresses more specific concerns relating to healthcare. In particular, it considers the increasing demand for accountability and the struggle of management accounting systems to pursue cost effectiveness and quality, in turn signaling how and why IS have the potential and power to reshape the healthcare context. In doing so, this book systematizes and rereads, in an integrated manner, the contributions on this theme, offering practitioners

and policymakers a basis for reflection by referencing a case study carried out in a healthcare organization located in the south of Italy.

This book produces a brand-new understanding of change management in healthcare. It allows readers to tap into the real potential of IS to achieve at last the long-whished-for improvements of quality and cost effectiveness that governments and policy makers have struggled to achieve in the last 40 years.

The value of the book lies in the completeness of its theoretical bases, which are supplied with due regard for practice implications and policymaking insights.

CHAPTER 1

INFORMATION SYSTEMS AND CHANGE MANAGEMENT IN COMPLEX ORGANIZATIONS

ROSANNA SPANÒ

1. A Classification of Information Systems

The introduction of information systems (IS) can considerably change the decision-making and operational activities of the administrative functions of any company (Inghirami, 2008; Mancini & Marchi, 2004; Marchi, 1993). Before examining the methods and consequences of IS implementation, it is necessary to remember that the administrative function is primarily connected to the performance of the data collection activities, which together with the organization and management activities, constitute the main activities in the life of the company.

The collection and reporting activities make it possible to recognize the system of monetary and non-monetary quantities and to guide organizational and managerial choices. In fact, the availability of internal and external economic, financial, and asset information related to the health of the company, the markets in which it operates, its internal processes, and so forth depends on this survey. Therefore, the administrative function has the task of collecting all the statistics about the company that will provide a clear, truthful, and correct representation of the management performance in order to provide stakeholders with the information necessary to explain the existing causal relationships between the way management operates, the decisions taken, and the results achieved.

From this perspective, the IS is an integral part of the administrative function and includes all the mechanisms for detecting, processing, and communicating data, monetary and otherwise, derived from economic transactions from exchange, production, and consumption operations. This includes complex operations relating to the calculation of the economic results for the financial year, the preparation of forecasts, the evaluation of

the results achieved, and the collection and classification of information of a strategic nature.

Due to the high number of operations that corporate IS perform within modern companies, it is necessary to classify different types of IS as the activities subject to observation and the flow of information transmitted vary. Most accredited literature distinguishes two types of IS according to the hierarchical level of information: operations information systems (OIS) and business intelligence systems (BIS) (Laudon & Laudon, 2006).

OIS play a strictly operational role within the company, enabling the automation and optimization of existing processes or, in some cases, the simulation of new processes in order to evaluate their efficiency. More precisely, they play a supporting role in the different operational activities by taking over operations ranging from the recording of daily transactions (transaction processing systems) to the control of physical-industrial processes (Business Process Control Systems), up to the monitoring of information flows generated by communicative and productive interactions between different work groups (office support systems). These systems include: management systems, which pursue the goal of computerization of structured and repetitive activities concerning processes and operating sectors; workflow management systems, which normally integrate and formalize workflows allowing for maximum automation; systems for office automation, which allow for the optimization of typical office activities (text processors, management of tables, graphs and drawings); internal communication systems, which are able to communicate different subjects quickly (corporate chat, internal messaging system); and statistical measurement systems, which allow for the measurement of certain phenomena (internal and external) and the development of indexes useful for decision-making (Hasan & Ditsa, 1999).

It is widely believed that OIS allow the company to improve operational efficiency. In fact, from a strictly operational standpoint, the primary effects of the introduction of an IS is generalized improvement in the company's performance due to the greater speed and accuracy of data processing, and the greater timeliness with which the information is available to management who can use it to increase productivity and reduce management costs (Laudon & Laudon, 2009).

The second category of IS are business intelligence systems (BIS). This category includes all those information systems set up to support the decision-making processes (strategic-decision support) that are carried out by company management which allow for the rapid implementation of strategic directives and the reshaping and/or integration of real-time strategies in an effective and efficient way. BIS can usually be divided into

three categories: management information systems (MIS); decision support systems (DSS); and executive information systems (EIS). MIS are systems that allow analysis support and evaluation of unstructured decisions typical of the company's control level. They support the control and planned decision-making activities, only partially structured, which require codified and standardized information. These IS allow for the collection of information produced by the transaction processing systems and distribution of the infortation to the people in charge of the centers in order to assess the established objectives (think, for example, of the reports concerning sales systems, inventory control, variance analysis, etc.).

DSS are systems that allow for the comparative evaluation of alternative hypotheses in support of non-structured decisions. They support unscheduled decision-making activities and high-uncertainty unstructured activities such as multidimensional data analysis systems, "what if" analyses, and resimulations. Therefore, they are used at different hierarchical levels to make semi-structured decisions (Asemi, Ali, & Zavareh, 2011). The DSS data collected from the production systems, through special processing, transform them into reporting support for management decisions (Al-Mamary, Shamsuddin, & Nor Aziati, 2013).

Literature assigns these systems the merit of supporting management in the decision-making process by modeling, formulating, calculating, comparing, and selecting the best possible combination of data to predict future scenarios with limited and controlled margins of error (Heidarkhani, Khomami, Jahanbazi, & Alipoor, 2013; Pighin & Marzona, 2005; Wilkinson, 1991).

Finally, the EIS are systems that allow top management to present summary data with high interactivity and high presentation flexibility (company dashboards). They provide critical information from a wide range of internal and external sources (from the MIS and from the DSS), making them accessible and interpretable but also, above all else, expendable for the purpose of solving structural and priority problems. The EIS support management in the analysis of the sector in which the organization operates, in the identification of long-term trends, and in the correct planning of competitive strategies. Table 1 below offers a brief summary of the main features of the cited BIS.

Table 1: ***BIS Features***

	Management Information Systems (MIS)	**Decision Support Systems (DSS)**	**Executive Information Systems (EIS)**
Function	Produces information for assessing management	Supports management	Integrates and substitutes operational activities
Structure	Constant and coherent	Flexible	Constant and coherent
Use of the support	Careful use	Active use	Passive use
Prevalent orientation	Effectiveness and efficiency	Effectiveness	Efficiency
Time horizon	Past actions	Forward looking	Current activities
Advantages	Timely and reliable	Requires a specific model	Precise and accurate
Models employed	Standard reporting signaling any deviation	Specific model	Predefined model

From the above information, it is possible to organize the different types of IS based on the relevance of the activities carried out by referring to a widespread model such as Anthony's pyramid (Anthony, 1965). Anthony proposes an interpretative model in which three groups of decisions are identified using their respective information systems: strategic decisions (EIS), tactical decisions (MIS), and operational decisions (transaction processing systems—TPS). Decisions are organized following a precise hierarchy mirrored by the pyramid shape.

At the base of the pyramid are structured activities that require operational decisions and are substantiated in a set of processes which are necessary for carrying out the typical activity of the company. These decisions concern the activity of operational control and are programmable, recurrent, and delegable at lower levels of the corporate structure. These activities involve transaction processing systems and office support systems.

The central level of the prymaid contains the little structured activities whose execution requires tactical decisions, all that fall within the

directional control activities and are connected to the preparation and management of the resources necessary to achieve the final objectives. Therefore, this level includes all the decision-making programmed processes (typically: short-term decisions and control of routine activities such as production launch or machine load assignment) and involves MIS and/or DSS.

Finally, in the highest part of the pyramid it is possible to identify the unstructured activities that require strategic decisions which compete with top management. They include all unscheduled and long-term oriented decision-making processes that permanently bind management activities and typically involve EIS (Laudon & Laudon, 2009). It is, therefore, possible to affirm that the EIS are at the top of the pyramid since they include management support systems which analyze the sector in which the company operates to identify long-term trends and ensure the correct planning of competitive strategies. These systems, created in such a way as to be used directly by subjects placed at managerial levels with a high level of seniority, guarantee a high degree of personalization while maintaining essential characteristics such as ease of use, orientation toward effectiveness, flexibility, support for unstructured decisions, and the possibility of using internal/external sources.

Going beyond the subdivision of information systems into OIS and BIS, a broader categorization is now emerging into transaction processing systems, business process management systems, and office support systems, as well as management formation systems, DSS, and EIS.

Once the different types of information systems have been identified, we can focus on the types of activities they support and the types of decisions they make (indicated below).

For instance, the transaction processing systems and the office support systems allow operational decisions and support repetitive and highly structured activities. On the other hand, since the EIS allow decisions of a strategic nature, they are tools to support unstructured activities typical of top management.

Over time, numerous authors have highlighted how the recent technological innovations have favored the advancement of computational science by progressively and positively influencing the transition from “tailor made” models (static and complex) to models based on flexible and adaptable information systems from different business contexts. In fact, modern technologies at the service of the company have made it possible to automate the process of representing the state of the company and, in particular, the activities of detecting company sizes which make them more efficient.

In this context, reference is made to company information systems (hereinafter also Information Systems or IS), understood to be the combination of individuals and technologies that allow for the performance of multiple activities such as data collection and processing and the automatic dissemination of information which allows the company to respond to the demands of the external environment more quickly and effectively (Quagli, Dameri, & Inghirami, 2005). Generally, the term information system refers to an ordered set of elements, which are heterogeneous and complementary to each other, which include any combination of actors, hardware, software, communication networks, and databases, and involve procedures that collect, store, and distribute information in a given environment (the company; Aureli, Cesaroni, Demartini, & Paoloni, 2004; Camussone, 2000; Ciborra, 1998; Coda & Camussone, 1988; Corsi, 2008; Marchi, 1993; Quagli et al., 2005).

In such an organization, individuals communicate with each other through physical devices (hardware), information processing algorithms (software), communication channels (networks), and stored data (databases) (O'Brien & Marakas, 2006; Pawlak, 1981). The correct performance of these activities presupposes that the ISis designed by following the structure of the company. It is, therefore, possible to affirm that it presents a dynamic nature and is subjected, during the entire life of the company, to evolutions and changes caused by internal and external factors and by time and space (Wilkinson, 1991).

Furthermore, the information systems have an intrinsic value in terms of tools with respect to the corporate decision-making system and they provide the information needed by company management to make rational choices with respect to the company objectives. This task requires the implementation of procedures that allow for the collection of raw values (known as data) and their transformation into information to support the management process or the performance of the company's ordinary activity. Moreover, the more complex the corporate processes are, the more complex these procedures become from a strategic and organizational point of view.

The data collected concerns phenomena of great interest to the company. Interpretative models are used to catalog the data and information needed by the intermediate and/or end users. This means that the IShas no limit as to the kind of data it can collect. Rather, it selects what is needed to provide intermediate users with numerical/symbolic representations of a phenomenon, events, or objects. The information system takes on a different relevance as the market—and the size and strategy of the company operating in that market—changes. Therefore,

there is no single best way to create and define a corporate information system, instead each company will have to prepare its own according to its internal needs and external factors.

The optimal preparation of an information system requires the identification of all the phenomena (internal and external) that the company has an interest in representing, enabling it to establish the priorities regarding the data to be processed, and to maintain a good level of effectiveness and efficiency. In order for this to happen, it is necessary to carry out a preliminary analysis concerning the role of the company in the market in order to precisely define which phenomena are to be represented. Secondly, it is important to establish the methods for recording and representing them, defining both the desired level of detail and the reference time horizon. Finally, it is necessary to clarify the kind of information that the company intends to obtain as well as who the recipients of the information are and the ways in which it will be used.

Thus, the information system has a dual nature: on one hand, it carries out operational support activities and, on the other, it has information transfer activity. Operational support activities are those related to the computerization of information flows that allow for a reduced need for labor and that increase the speed of processes and the quality standard of the entire company's activity (Van der Aalst & van Hee, 2004). Instead, the information transfer activities are all those activities that allow for the rapid delivery of information to the final decision-makers through the automation of information flows and the greater speed of use of information (Laudon & Laudon, 2009).

All these activities provide the company with benefits in the planning phases (reference is made to the definition of the achievable objectives, to the choice of strategies to be implemented, to the analysis by scenarios, etc.) and in control and monitoring (allow automation, guaranteeing updated information at all times).

2. A Focus on IS Design, Developments, and Risks

The correct implementation of an information system (or its change) requires defining and tracking company information flows to obtain a double advantage: first is to highlight information anomalies, data losses, and inefficiencies; and second is to analyze the criticalities that could occur during the change process (Laudon & Laudon, 2009).

On this point, literature has developed over time a cycle known as the Information System Development Life Cycle (ISDLC) which is useful to create, develop, and implement each information system through an

iterative process composed of different steps that involve the execution of both technical and managerial activities (Dumas, van der Aalst, & ter Hofstede, 2005; Roebuck, 2012; Van der Aalst and van Hee, 2004).

This operation requires a proper follow-up analysis method, starting from the company situation (c.d. company check-up) and continuing with the study of the company's activities, the identification of problems, critical issues, and possible solutions.

Tracing information flows means defining and representing the ways in which information moves within the company, highlighting the moments of data collection, processing, and dissemination. This makes the definition of the information flow close to that used for the elaboration of information models or ISO certifications. Therefore, it is necessary to follow a roadmap, which should include:

1) company check-up;
2) identification of business activities and processes;
3) identification of information criticalities;
4) re-mapping of information flows; and
5) evaluation of the information systems and any proposals for improvement.

The activities listed above must be carried out jointly to enable the company information to be represented (Deming, 1982; Pozzoli, 2013). In general, all activities are aimed at verifying the needs of the IS and evaluating, where necessary, the changes of the same. In fact, starting from a preliminary analysis of the company it is possible to identify the information activities, as well as the main critical points of the IS, through a matching between company activities and information flows. This action allows for a mapping of the information processes and therefore information on the IS health. The overall assessment of the IS is carried out on the basis of the information obtained and should lead to a series of managerial choices concerning the acceptance or change (improvement) of the same.

As mentioned above, the first phase consists of the corporate check-up. If the company reveals a need to modify its information system, it seems necessary, at least at first, to know all the activities (operational and management) in which the information system is involved. This analysis will require an in-depth examination of different aspects such as the sector to which it belongs, the size of the company, governance, and whether it is part of a group (national or international). To this end, it is important to request, control, and redefine the company's business model, the

organizational structure, and the economic and financial situation, and thus obtain a global vision of the company. The information obtained will make it possible to carry out an in-depth and comprehensive analysis of the company in order to allow for a clear view of all business activities and processes and for the identification of information needed to be introduced/produced. Finally, it is necessary to identify all the criticalities that could compromise the health of the information system. This phase consists, therefore, of defining and getting to know the company in order to identify the critical aspects that will be the subject of subsequent investigations.

The second phase is the identification of business activities and processes. The main purpose is to represent the company system as a set of interrelated processes, highlighting the organizational structure, strategic orientations, and objectives. More precisely, it is necessary to observe the complex internal processes by highlighting the interconnections between the different functions. The conducting of this activity requires the creation of a process map, a fundamental organizational tool that allows for a full understanding of the dynamic functions and the information exchanges between the different business functions using a graphic approach (De Vivo, De Luca, & De Luca, 2012). The importance of this phase for management is striking: mapping all the processes and activities carried out within the company makes it possible to imagine the shape of the corporate information system in order to align it with the existing macrostructure, improving the individual processes, highlighting the criticalities and informative bottlenecks, and guiding their development and continuous improvement (Brusa, 2000; 2011; Riccaboni, 2018).

The third phase is the identification of information criticalities. In this phase it should be remembered that the information must be identified, detected, and disseminated in the appropriate manner and at the appropriate time in order to enable the company and its members to respond promptly to market requests. Therefore, it is of primary importance to define a correct internal communication strategy that allows all the corporate subjects to have the necessary information at the same time, avoiding situations of information overflow or information overlap (Gross, 1964; Laudon & Laudon, 2009). In order for this to happen, management must convey the importance of communication to staff, while employees must become aware of their role within the IS. During this activity, it is necessary to identify the most sensitive information areas taking into account generic inefficiency factors (information overflow, loss of information, duplicate information, etc.) as well as their position on the organization chart (presence of informative bottlenecks). This makes it

difficult to identify critical areas a priori or ideal types of IS for all organizations. The first step to be carried out is to identify information criticalities in an in-depth examination of the organization through the study of the organization chart and the map established in the previous phases.

Once the diagnostic phases of the IS analysis process have been completed and the critical issues are analyzed, the active phase of the re-mapping of the information system is entered (Hammer & Champy, 2009). This phase is the first to be considered as active. It is here that the management's effort consists of requalifying the flows of information generated by defining concrete observable, quantifiable, and verifiable objectives of change. These indications represent requirements for the subsequent redesign phase. It is clear that the redesign phase requires a creative approach and is difficult to schematize in predefined activities (Lazzi, 1999). Thus, there is no one best way of intervention to follow.

In light of the above, in the redefinition of the information system it will be necessary to:

- ✓ eliminate superfluous activities that do not add value to the product/service (information redundancy, inappropriate control activities, etc.);
- ✓ rationalize the necessary activities, trying to eliminate bottlenecks (where they emerge);
- ✓ simplify and adapt the information process;
- ✓ prevent the possibility of errors and problems of an operational nature by involving the service end user in the redefinition process in advance;
- ✓ imitate well-known cases and solutions to learn from cases of excellence (both internal and external); and
- ✓ automate and improve control and monitoring of activities.

The last phase of the roadmap is the assessment of the IS and any improvement actions. This phase invites the company management to reflect on how it acted upon previous analyses and, from that, make decisions for the improvement of the company information system. A coherent and rational decision cannot disregard the measurement of the results achieved by the current IS and the benefit that can be achieved by changing it.

The design phase is perhaps the most delicate of the implementation of an information system. This stage requires you to grasp all the needs of the

business activity in order to provide a general benefit to all internal activities.

For each improvement proposal it will be necessary to analyze the effects of the change on the organizational structure and on the internal and external coordination mechanisms. This phase is closely linked to the road map since, only after the definition of the business needs, will it be possible to arrive at the project of a new information system that allows for the various target attributes to be combined (Previtali, 2012). At the time of planning, it is necessary to respect a series of characteristics inherent in the simplicity of use, the culture, the business needs, and the required performanc. Incorrect assessments in this context represent the main reason for the failure of the information system. In this regard it is important to point out that a common error is paying excessive attention to technical aspects, leaving out aspects of an operational and organizational nature. The result of this approach is often an information system which is technically high-performance but which is incompatible with business needs (Laudon & Laudon, 2009; Van Dooren & Van de Walle, 2010).

Following the design phase of the ISit is necessary to plan the technological infrastructure in support of the same in order to allow management to know the actions necessary for the change. The planning is aimed at maximizing the return on ICT investments by minimizing the costs and risks associated with their acquisition and use (Lazzi, 1999).

Maximizing the return on investment means that the commitment to the development and use of information systems must produce results in terms of improving the overall operations of the organization while minimizing costs and risks. This commitment must be guided by efficiency criteria and economy and be managed in such a way as to ensure the success of the initiatives undertaken. In essence, planning aims to lay the foundation for optimally managing the data and information needed by companies. Usually, the adoption of an information system planning cycle is correlated to the will to overcome an unguided development situation allowing for the assumption of an overall management perspective of information resources (Sannino, 2003; Brusa, 2011).

This approach makes up the Deming cycle (Evans & Lindsay, 2005) which identifies four phases for the development of change: the planning phase that concerns the definition of the objectives; the project implementation phase; the evaluation phase that allows the measurement of the results of the operational activities; and the intervention phase in which corrective actions are prepared. According to this model, planning constitutes a moment of systematization and directional synthesis that

completes and formalizes the processing carried out in an iterative manner throughout the year through the activities envisioned in the various phases of the cycle. During this first phase, the organization establishes the need for a specific information system and documents its aims. The planning of a security structure should begin at this stage to allow information to be correctly processed, transmitted, and/or stored. A far-sighted and attentive approach to the initial phase is of vital importance for the correct planning and future realization of the entire architecture of the security system, as well as for the effective planning of the strategic objectives in the medium to long term.

In particular, during the planning phase the activity of elaboration and the revision of the technological vision are carried out identifying the strategic direction to be followed in the subsequent period and the main areas of intervention, the service and technological choices, the objectives to be achieved, and the definition of their priorities.

The performance of this activity requires company management to define an action plan that formalizes the commitments in terms of resources and time, defines the priority choices, and takes into account any economic and financial constraints.

In the implementation phase, a series of feasibility studies are envisioned for those projects that, at the time of plan development, had not yet reached the level of in-depth analysis sufficient for a reasoned and conscious decision on the investment necessary for their realization. This phase requires the definition of the project and an implementation strategy that depends on the economic, financial, and human resources available to the company. Taking care of this aspect means acquiring, in addition to a suitable structure, the know-how and complex knowledge and skills necessary to correctly implement the new technological infrastructure. In fact, as often happens, information systems are not correctly introduced into the company system, causing enormous inefficiencies and incorrect performance evaluation (Laudon & Laudon, 2009; Manes Rossi, 2010; Manes Rossi et al., 2016). Only after the definition of a structured project is it possible to start the operational migration activity toward the new ICT infrastructures. The implementation phase does not end with the first implementation but requires the evolution of the systems, the implementation of technological adjustments, and possible small improvements.

The verification phase is concomitant with the implementation phase and requires the management of the projects and various other components through the information collection on the status of the processes and the definition of a continuous monitoring system that allows for the

establishment of the level of effectiveness and efficiency of services and business processes (Maffei, 2014). In this phase, the collected data are processed giving rise to a system of indicators capable of providing information on the yield and health of the company information system (Baynon-Davies, 2002).

The intervention phase requires the elaboration of re-engineering interventions of the processes that produce organizational and technological change programs, in particular defining the basic requirements for the development and revision of the application systems. It requires a substantial re-engineering of the processes or a partial review of the company processes toward their innovation and optimization.

3. Theoretical Frameworks to Tap into IS Implementation Logics

In order to solve any implementation problems and to provide a useful model consistent with information system studies, Davis published a study in 1989 in which he presented the technology acceptance model (TAM) (Davis, 1989).

The model in question was developed with two main objectives. In the first place, the users, providing numerous theoretical insights into the design and implementation of effective and efficient information systems, created it in order to provide and/or improve the understanding of the technology acceptance process. Secondly, the TAM should provide the theoretical basis for the creation of a practical methodology, which can offer the level of acceptance of the users in order to guarantee that designers and implementers of information systems evaluate new proposals before implementation (Saga & Zhund, 1993; Van der Heijden 2004).

Through the application of the Davis model it is possible to carry out a real test of the degree of acceptance by the end user, understanding at an earlier stage the propensity to change the entire information environment, as well as the motivation of individuals to use alternative systems. It is noteworthy that the information on the degree of acceptance of users before the change occurs plays a crucial role with respect to the probability of success of the implementation of the information system, and that allows management, especially in the early stages of development, to make corrections (Davis, 1989; Ginzberg, 1981).

In the TAM, the completion of a specific action is preceded by intention, the determinants of which are the perceived usefulness (PU, i.e., the utility perceived by the users) and the perceived ease of use (PEOU).

According to Davis (1989), these attributes are the simplest determinants of the decisions for the adoption and use of the computer system, and they allow for the prediction both of attitudes toward the use of the system, and of the propensity/aversion of the end user. A profound understanding of the propensity/aversion of the information system actors, with respect to the possible technological changes, allows for the determination of efforts in the change phase, guaranteeing an effective and efficient use of resources available to the company, mitigating the risk of counterproductive choices.

The first attribute, perceived usefulness, represents the expected degree of improvement of an individual's work performance thanks to the technological introduction: it is therefore possible to understand the benefit in terms of improving the quality of the working environment and the routines as perceived by the end users (Davis, 1989).

The second attribute, the perceived ease of use, can be defined as the level of difficulty perceived by the individual in relation to learning a new work routine. Quoting Davis (1989), it represents the degree or level with which the user believes that the use of that particular technology can be carried out without effort. In summary, the attitude represents an individual's position toward the use of a particular technology, while the behavioral intention refers to the final behavior, that is, to the actual use (or non-use) of the same.

The first two attributes represent the basis on which technological use decisions of corporate actors rest. They directly influence attitude and indirectly influence behavioral intentions. Furthermore, the perceived ease of use is linked to perceived usefulness by a causal link: the more a technology is perceived by the corporate actor as being simple to use, the more it will be perceived as useful.

The model assumes that a technology perceived as useful and simple will present a high level of attitude, this will generate the intention of use by the actor of the information system.

Thanks to the good predictive value and the solid theoretical base, the TAM has constituted a valid starting point for numerous empirical studies carried out over time regarding technological adoption and information systems, so as to be able to explain between 30% and 40% of user behavior (Ramdani & Kawalek, 2007; Warshaw & Davis, 1984).

This model has been subject to numerous criticisms. Some authors have labeled it too simplistic, claiming that it is not possible to identify only two determinants in human decisions. These critics have underlined the need to introduce new theoretical constructs that explain the push of an individual toward adoption of a given technology (Legris, Ingham, & Collerette, 2003). Furthermore, the TAM has been widely contested for its

limited predictive power over the implementation of technology (Chuttur, 2009), for its lack of practical value (Benbasat & Barki, 2007), for the subjectivity of ease of use (Dalcher & Shine, 2003), and for the absence of a risk perception (Pavlou, 2003).

Some subsequent studies have tried to integrate the model with different variables to overcome these limitations, but with conflicting results (Dalcher & Shine, 2003; Pavlou, 2003).

Venkatesh and Davis (2000) developed and tested a theoretical extension of the model, unifying it with the studies of numerous authors concerning the decision-making process of corporate actors (Adams, Nelson, & Todd, 1992; Agarwal & Prasad, 1997; 1998). As already seen, numerous authors have criticized the TAM by observing that human decisions depend on a set of factors that exceed the perceived usefulness and simplicity of use, thus deeming the model to be too simplistic and not useful to predict the propensity of use of individuals (Adams et al., 1992).

On the basis of these studies, Venkatesh and Davis (2000) proposed a first extension of the technology acceptance model presented with the name of TAM 2 and a further version named TAM 3 (Venkatesh & Bala, 2008). With reference to TAM 3, the authors introduce a series of constructs considered to be precursors of the perceived ease of use (the computer self-efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment, and objective usability) and of perceived usefulness (subjective norms, image, job relevance, output quality, and results demonstrability).

With reference to the determinants of the perceived ease of use, according to Venkatesh and Bala (2008) it is possible to identify two types of factor underlying the perception of the simplicity of use of a technology: anchor (inherent in the expectations of ease of use) and adjustment (or adjustment variables; Venkatesh, Morris, Davis, & Davis, 2003). Each of these variables consists of micro-constructs derived and tested in studies by other authors.

The four anchoring variables are: the self-efficacy computer, defined as the judgment of an individual relative to the degree to which they are able to perform a task through the use of the computer (Compeau & Higgins, 1995); the perception of external control, defined as the degree of external support that an individual hopes to receive during the first phases of use of the system; computer anxiety, considered as the degree of apprehension of an individual before the possibility/necessity to use technology; and computer playfulness, defined as the degree of spontaneity of the individual in the use of technology (Martocchio & Webster, 1992).

The two adjustment variables are: perceived enjoyment and objective usability. Perceived enjoyment is defined as the extent to which the activity of using a system is perceived as pleasant beyond the performance it offers (Venkatesh, 2000), and objective usability requires the performance of a comparison of systems based on the actual level of effort required to perform specific tasks (Venkatesh & Bala, 2008).

Finally, TAM 3 expresses the experience variable (not present in the previous models), considering it as a moderation factor both in the relations between perceived ease of use and perceived usefulness, and between the adjustment and anchor variables and the perceived ease of use.

With reference to the constructs preceding the perceived usefulness, the authors identify: "The subjective norm is defined as the perception of an individual that the people he or she considers think that he should (or should not) carry out a specific action" (Ajzen & Fishbein, 1970, 1977). This attribute refers to the possibility that an individual chooses to perform a given action (or assume a given behavior), even without deeming it correct, with the sole purpose of obtaining the consent of the reference social group (Davis, Bagozzi, & Warshaw, 1989; Lucas, Ginzberg, & Schultz, 1990; Mathieson, 1991; Moore & Benbasat, 1991; Taylor & Todd, 1995; Thompson, Higgins, & Howell, 1991;). This attribute consists of three constructs.

Voluntariness is an attribute that refers to the voluntariness in the use of the technology introduced following the studies of Hartwick and Barki (1994). According to these scholars, the Subjective Norms (SN) has a significant effect on the intention to use when the user is subject to the choice of a third party (and is therefore forced to use the new technology), while it has a non-significant effect when they have the freedom of choice. This effect was defined as the compliance effect of the subjective norm on intention, and operates in the circumstance in which an individual perceives that an actor, placed higher up on a hierarchical scale, has chosen them to perform a certain task. According to the authors the voluntariness is a moderating variable that depends on how much the final users perceive the adoption of the technology as something mandatory (Hartwick & Barki, 1994).

The image is an attribute that refers to the willingness of individuals to maintain a positive image of themselves in the social group to which they belong. It represents what some have defined as the effect of using technological innovation on the image of an individual in a social group of reference (Moore & Benbasat, 1991). According to Venkatesh and Davis (2000), this attribute is positively influenced by the SN. As a result, when

people consider the use of a technology to be something important, then its use contributes to giving greater importance to the figure of the individual in the group. The improvement of the image acts as the basis for greater productivity: an individual might perceive that the use of a technology allows him to improve his work performance, thus improving his image in his company.

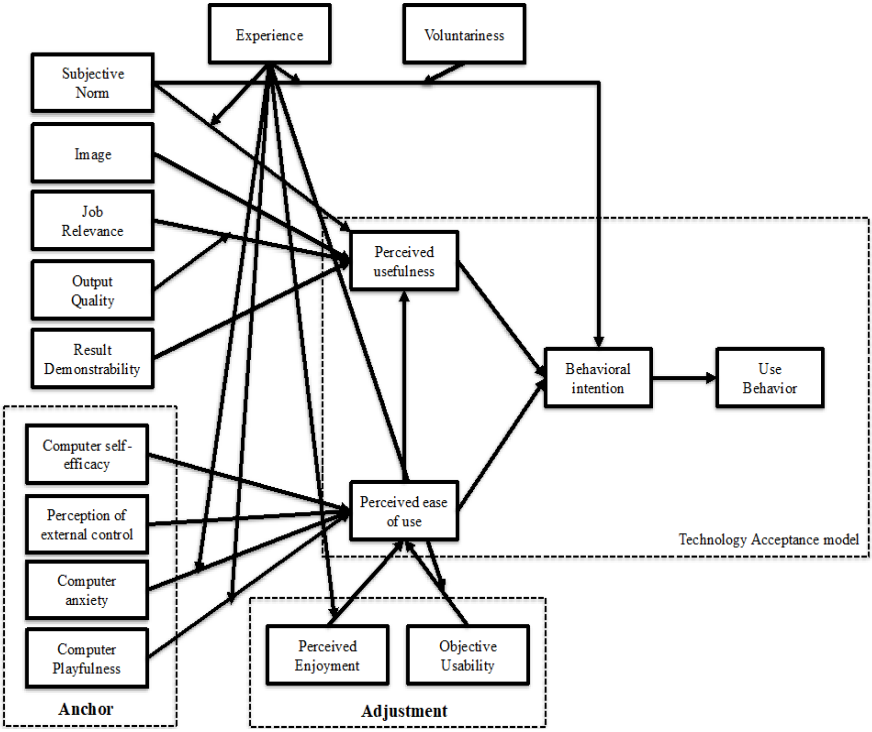
Job relevance is a fundamental variable to be considered in cognitive processes, defined as individual perception regarding the applicability of technology in one's work (Venkatesh & Davis, 2000). This attribute represents a cognitive process, with a direct effect on the perceived usefulness that is kept separate from the social processes. Some authors have criticized this choice, pointing out that factors such as image are closely related to job relevance (Venkatesh & Davis, 2000).

The output quality is the second variable linked to the cognitive instrumental process. The inclusion of this factor starts with the assumption that each actor decides whether to adopt a technology and will try to quantify the improvement of the quality of their work. Therefore, this attribute has a direct relation to perceived usefulness, from which it remains distinct, as does job relevance; in fact, these factors give rise to different processes of judgment and therefore cannot be combined.

The demonstrability of the results is the last element of novelty introduced by the model. This factor concerns the tangibility (of improvement) of the results obtained by applying innovation (Moore & Benbasat, 1991; Venkatesh & Davis, 2000) and has a direct and positive effect on perceived usefulness. More precisely, according to the authors, an innovation is perceived by the users to be more useful the more tangible the benefit deriving from its adoption (Agarwal & Prasad, 1998; Gefen & Straub, 1997; Hess, McNab, & Basoglu, 2014).

The last variable inherent in the social influence is experience. The TAM theorizes that a subjective norm is mediated by the experience of individuals: the greater knowledge accumulated over time has an effect on the personalities and self-confidence of users. This implies a lower inclination of the actors to the alignment of their behaviors to the social group to which they belong (motivation to comply).

Figure 1. Technology Acceptance Model 3



The TAM 3 allows for the same acceptance process as its predecessor to be obtained, while guaranteeing greater precision in the definition of the determinants of simplicity of use. However, it is noteworthy that with the division of determinants in the categories of anchor and adjustment, the authors of the model admit the existence of an iterative process in acceptance decisions: individuals learn through experience and this allows a technology, initially perceived as difficult, to be accepted over time. The acceptance process is therefore no longer linear, as stated in the previous models, but requires a series of temporal variations due to the accumulation of experience.

In order to eliminate the weaknesses of the previous models, in 2003 a new model was introduced, known as the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). The authors' aim was to create a definitive theory for measuring the degree of technological acceptance, through the integration of variables and

theoretical constructs coming from numerous pre-existing models and theories, belonging both to the field of IS studies and to that of sociology.

Following a careful study of the existing literature and the results obtained by other researchers, Venkatesh and other scholars were able to identify the most significant theoretical constructs, thus creating a new model (Ajzen, 1985; Davis, 1989; Fishbein & Ajzen, 1976; Rogers, 2010).

According to this innovative vision, the basis of the intention to use technology (and therefore behavior) contains four constructs: performance expectancy (PE, expectation about performance); effort expectancy (EE, expectation on the effort to support); social influence (SOI); and facilitating conditions (FC, conditions that make it possible to make the adoption of a technology less traumatic) Venkatesh et al., 2003).

The first three factors have an indirect effect on use behavior passing through the behavioral intentions. The last factor pertains directly to the behavior of use. Each of these theoretical constructs is formed by variables that are found to be significant in numerous theoretical models. The following are the definitions, accompanied by a brief description of each composition.

Performance expectancy is defined as the level of an individual's expectation with respect to the benefits provided by technological innovation to the work of the user. More specifically, this construct should measure the level of expectation of IS actors with respect to improving the working conditions due to the adoption of technology. It can be broken down into five key factors: perceived usefulness; extrinsic motivations; job fit; relative advantage; and outcome expectations (Venkatesh et al., 2003).

For greater clarity, Table 2 shows the reference theory, a brief description, and the author who introduced it for each previously named construct.

Performance expectancy is the most important attribute of prediction of intention, remaining significant in the cases of both voluntary and mandatory adoption. It is noteworthy that the effect of performance expectancy on intention could be mitigated by personal factors such as age and gender (Im, Hong, & Kang, 2011).

The second construct, the expectancy effort, represents the measure of the perception of simplicity expected in the use of the system. The construct consists of three variables: perceived ease of use; complexity; and ease of use (Venkatesh et al., 2003). This construct is significant in the cases of both voluntary and mandatory adoption of technology, but could be affected by the influence of certain personal factors such as age, gender, or experience (Venkatesh et al., 2003).

Table 2 - ***Factors influencing performance expectancy (adapted from Venkatesh et al. 2003)***

Construct	Theory	Definition	Author
Perceived usefulness	Technology acceptance model (TAM)	Measures the degree of expected work performance improvement, following the introduction of technology.	Davis (1989)
Extrinsic motivations	Motivational model (MM)	Measures an actor's desire for the use of technology in his business.	Davis et al. (1992)
Job fit	Model of PC utilization (MOPCU)	Expresses the expectation of the actors regarding the improvement of their working skills.	Thompson et al. (1991)
Relative advantage	Innovation diffusion theory (IDT)	Represents the improvements expected from innovation compared to the previous technology.	Moore and Benbasat (1991)
Outcome expectations	Social cognitive theory (SCT)	It represents the improvement/worsening of the expected result of one's work following the implementation of the technology.	Compeau and Higgins (1995)

The third theoretical construct considered by the authors is social influence. This represents the level of influence that the opinion of a user's social circle may have on a particular action. In particular, it allows us to understand the importance a user attaches to the idea of other individuals regarding the use of a new information system. The different representations of social influence in the various models led the authors to identify three key factors: subjective norm, social factors, and image. According to the authors, this construct is mitigated both by personal factors such as gender, age, or experience and by voluntariness in the use of technology.

The last theoretical construct to be described is that of facilitating conditions. These refer to the degree of importance that an individual atributes to what others think about the use of the new information system. As in the previous case, for this construct, three key factors have been identified following different representations: subjective norm, social factors, and image. It is important to note that this construct has a direct effect on use behavior (Venkatesh et al., 2003).

In the authors' view, the macro-constructs described so far have a direct effect on behavioral intention and user behavior. They are partly mitigated by factors such as age, gender, personal experience, and voluntariness of use. The image below clarifies what has been said up until now by providing the definitive model proposed by Venkatesh et al. (2003) and other scholars.

In Figure 2 it is possible to see the four main constructs in the dashed box on the left. Of these, three have an effect on the behavioral intention (PE, EF, SI), while the last (FC) has a direct effect on use behavior. In the box below it is possible to distinguish four mitigating factors: gender (the gender); age (age); experience (the level of experience in the relationship with a specific technology or in a specific field); and voluntariness of use, which refers to the degree of freedom of choice in the final use of innovation.

These factors can mitigate or amplify the effect of the constructs just described on behavioral intention and user behavior.

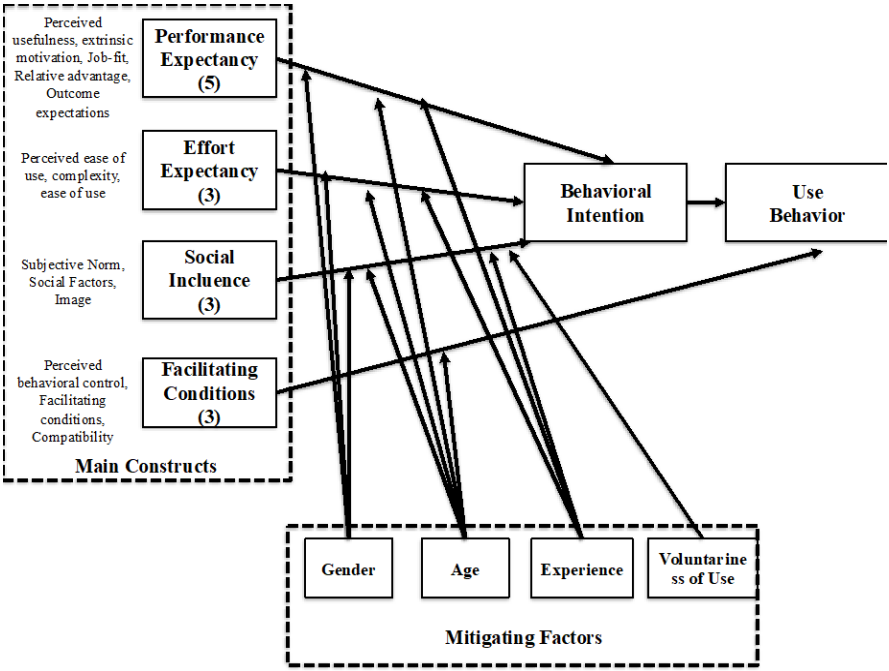
Despite the enormous progress made by the TAM, the UTAUT has not been exempt from criticism. If on the one hand the model and the subsequent extensions provide a very meaningful and thoughtful presentation, on the other its predictive power, with respect to the intention, is entrusted to 41 independent variables to which at least a further eight are added and used to predict behavior.

This multitude of variables inevitably leads to a state of chaos (Bagozzi, 2007)[1], which makes it difficult to fully understand the technology

[1] BAGOZZI, 2007, p. 245: "The exposition of UTAUT is a well-meaning and thoughtful presentation. But in the end we are left with a model with 41 independent variables for predicting intentions and at least eight independent variables for predicting behavior. Even here, arguments can be made that important independent variables have been left out, because few of the included predictors are fundamental, generic or universal and future research is likely to uncover new predictors not subsumable under the existing predictors. The IS field risks being overwhelmed, confused and misled but the growing piecemeal evidence behind decision making and action in regard to technology adoption/acceptance/rejection."

acceptance process; in this way the model is of little use to the needs of company management (Bagozzi, 2007).

Figure 2 - *Unified Theory of Use and Acceptance of Technology*



A second limitation, identified by different authors, lies in the use of mitigating factors. According to the critics, UTAUT turns out to be less precise than the previous models (TAM and TAM 2), since statistically significant results are achieved only thanks to mitigating factors (Van Raaij and Schepers, 2008). However, this model is the only one that considers the personal factors of the information system actors as components that contribute to decision-making. With regard to this, some authors have pointed out that the limited significance of macro-constructs is not to be attributed exclusively to mitigating factors, but to the high heterogeneity of the variables that compose them (Kijsanayotin, Pannarunothai, & Speedie, 2009; Van Raaij & Schepers, 2008).

A third criticism of the model concerns the composition of theoretical constructs. The grouping of a wide variety of different elements combined to reflect a single psychometric construct generates numerous problems,