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A Gap Between Theory and Practice in the Evaluation of ICT Investments. A Literature Review.

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***Abstract*—All benefits obtained from the implementation of investments in Information and Communication Technologies (ICTs) are sources of value for the investing firm. However, it has been considered that decision makers lack a structured methodology or a well-defined framework for evaluating said investments by integrating tangible and intangible benefits. Recent studies proffer empirical evidence that decision makers focus their analysis on quantifiable economic benefits while neglecting intangible benefits. A review of the specialized literature was conducted resulting in the identification of a gap between theory and practice in the evaluation of ICT investments. Even though theorists propose evaluation methods with quantitative and qualitative approaches, decision makers tend to focus their analysis on quantifiable economic benefits and limit the estimation of intangible benefits to subjective judgments. This paper organizes and structures the teachings of the specialized literature reviewed and provides a basis for future work that may aim to contribute to the development of new methodology for estimating the intangible value impact of ICT investments, and thus reduce the identified gap.**

Keywords— Decision makers, evaluation methods and techniques, evaluation of ICT investments, gap between theory and practice, tangible and intangible benefits, value contribution.

I. INTRODUCTION

Previous studies show that investments in Information and Communication Technologies (ICTs) can contribute to the value of the investing firm by positively affecting product/process diversification, process flexibility, work productivity, profitability, sales, and production costs [7], [39], [65]. They can also introduce notions of change –for this study this change is treated as *good* change– and new knowledge which need to be understood in their unique context since they may not necessarily be quantified only in economic terms [8]. Therefore, one can state that the value contribution of ICT investments to firmscan be of tangible or intangible nature depending on the type of benefits obtained, which means that the value created in the firm investing in ICT can reflect the tangible and intangible benefits perceived from the investment [4], [42], [52], [58], [67], [94]. Consequently, both types of benefits –tangible and intangible– obtained from the implementation of ICT investments should be considered as sources of value for the investing firm.

The evaluation of ICT investments has been the subject of debate for many years. It is considered that conducting a comprehensive evaluation of said investments is difficult due to their complexity and the frequent deviations in costs during their lifecycle [5] and because it requires multidimensional measurements that must integrate tangible and intangible elements [31], [45], [54], [74].

The literature reviewed provides with information on methods proposed for this end. Said methods can be classified in two categories: a) evaluation methods based on an approach on tangible elements and b) evaluation methods based on an approach on intangible elements. On this regard, Ahmad and Arshad [1] indicate that different perspectives and groundwork contribute greatly for the diversity of evaluation methods. Some use financial formulations that address costs and benefits of the ICT investment to be measured by assigning a monetary value, leaving intangibility of the ICT values to zero; however, some opt to use multi criteria approaches that consider several elements of ICT evaluation including intangible value of ICTs. Thus, ICT evaluation methods can be categorized with different perspectives such as: financial, non-financial, or multi-criteria dimensions [86].

Taking into consideration that this paper focuses on the value perceived from ICT investments in firms and that said value finds its source in tangible and intangible benefits, the aforementioned tangible and intangible "elements" are defined and treated in this study as tangible and intangible "benefits."

A tangible benefit is one that directly affects the organization's bottom line and profitability, and which can be measured directly and assigned a monetary value (the original concept of an organization's *bottom line* is about profit [35];

Elkington [22] later added social and environmental components, and he proposed the concept of the "*Triple Bottom Line*" which considers economic, social, and environmental factors for measuring the impact of an organization's activities). Examples of tangible benefits are increase in revenue and reduction in costs. In contrast, an intangible benefit has an indirect impact on the organization's productivity and performance, and it cannot be measured directly or quantified easily in terms of money, time, or frequency, or by using mathematical equations. Instances of intangible benefits are improved customer satisfaction and increased customer confidence [27], [56], [79], [82], [101]. Therefore, a tangible benefit is easily quantifiable while an intangible benefit is difficult to measure. Indeed, one could almost intuitively figure out how to quantify *increase in revenue* and *reduction in costs* just by being familiar with the terms "increase," "revenue," "reduction," and "cost," and thus determine that it is basically a matter of addition and subtraction of certain factors. However, measuring *improved customer satisfaction* and *increased customer confidence* seems to be a much more complex task considering that "satisfaction," and "confidence" may be measured based on various criteria or from different perspectives.

An ICT investment project may be initiated in response to a certain event or to pursue a certain goal [51], and thus it can be considered as a goal-oriented decisional process that should be executed within a delimited time horizon and in alignment with business initiatives and strategic goals defined by decision makers in a firm [57]. The Oxford's dictionary defines "decision maker" as "a person who makes important decisions;" thus, for this study, a decision maker in a firm is defined as a person who makes important decisions regarding ICT investments, namely decisions which are of great significance or value. Furthermore, people play a very important role from an operational point of view [4] in the extent of impact of ICT investments in the business. This "people" is treated in this study as all individuals in the investing firm who benefit from the use of the technology implemented in their business [57], that is, all "user beneficiaries" of the said technology.

These two groups –decision makers and user beneficiaries– would be in the best position to provide input information for the evaluation of ICT investments in a firm because the former (decision makers) are directly involved in the pre-implementation stage of an ICT investment project where strategic goals are defined, and the latter (user beneficiaries) are directly involved in the post-implementation stage where results are obtained.

Recent studies analyzed information gathered from the perceptual perspective of active employees [55] and from the perspective of decision makers [58] in connection with procedures and tools used for the evaluation of benefits obtained from the implementation of ICT investments in their organizations. Their results agreed in that organizations lack clear procedures to guide decision makers in the analysis of intangible benefits obtained from their ICT investments, and they focus on quantifiable economic benefits without taking intangible benefits into account.

Having these results as motivation and taking into account that references [4], [13], [42], [67], and [94] agree in that current evaluation methods which are commonly accepted do not provide with procedures to guide decision makers in the analysis of intangible benefits, this study reviews the pertinent literature with the purpose of contributing to knowledge construction on the process of evaluation of ICT investments, its definition, characteristics, actors, and methods. For this end, this paper provides with a review on the following topics: a) the process of evaluation of ICT investments, b) who decision makers are in said investments, c) how ICT investments contribute value to firms and user beneficiaries, and d) methods based on tangible and intangible benefits that have been proposed for their evaluation.

A gap was identified between theory and practice since even though the specialized literature proposes methods for evaluating ICT investments in scenarios where it is easy to measure their benefits and in scenarios where it is not, methods proposed for evaluating benefits which are difficult to measure are perceived as too broad in scope, difficult and expensive to implement, or not very accurate or effective [61], [91], [94], [104]; this seems to lead decision makers to focus on quantifiable economic benefits while neglecting the analysis of intangible benefits.

Based on the information gathered, the process of evaluation of ICT investments is conceptually mapped with an approach on the contribution of tangible and intangible value from said investments to firms, and thus a basis is provided for future studies which may aim to explore on opportunities to develop new methods for evaluating ICT investments, mainly with focus on intangible benefits in view of the identified gap.

The rest of this paper is organized as follows: Section II presents a review of the specialized literature; Section III presents the methodology used for this work; Section IV condenses the knowledge gathered from the literature review, Section V includes a summary of the study; and Section VI presents conclusions of the study and recommendations for future work.

II. Literature Review

This section reviews the specialized literature on the process of evaluation of ICT investments with an approach on their value contribution. Definitions are provided on who decision makers are in ICT investments, how ICT investments contribute value to firms and user beneficiaries, and on methods that have been proposed for the evaluation of these investments.

A. Evaluation of ICT Investments.

The evaluation process can be considered as a management tool associated with improvement and, as such, it should be integrated into the planning of institutional objectives and strategies. This process is a programmed activity of reflection on the action. Said action, object of the evaluation, can be either a) proposed for its future execution, b) in the process of execution, or c) already executed. The evaluation process is conducted through systematic procedures of collection, analysis, and interpretation of information and through

comparisons according to defined parameters. Its purpose is to make well-grounded and communicable value judgments based on activities and results (expected or obtained) [70].

The OECD [72] defines evaluation as the "systematic and objective assessment of an on-going or completed project, program or policy, its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide with information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipients and donors. Evaluation also refers to the process of determining the worth or significance of an activity, policy or program. An assessment, as systematic and objective as possible, of a planned, on-going, or completed development intervention." Therefore, from this definition we may derive for our study that the evaluation of an ICT investment project should be aimed to assess the most relevant characteristics of the same, from its planning stage through its post-execution stage including –without limitation– what the project is about, what objectives it is designed/expected to fulfill, the level of achievement of the objectives, and the impact of the implementation of the project in the organization. This should enable evaluators to collect reliable and useful information that help identify weaknesses and strengths so that success can be replicated, errors can be mitigated, and knowledge can be created.

The IDB [41] defines that evaluation involves the application of methods to determine the progress of a project in the process of reaching its objective during its execution, or to determine if it achieved and how it achieved, or not, that objective. The evaluation process combines different types of information with the criteria and points of view of the people involved or affected. It uses tools from fields such as statistics, economics and anthropology, and is mainly based on the concepts and procedures of scientific research methodology. It should be therefore understood that an acceptable evaluation of an ICT investment must follow reliable methods which are based on scientific grounds; it must also be organized and comprehensive of the people involved or affected in order to avoid bias in the analysis of the information collected.

The definition provided by the IDB [41] agrees with Valdés [100] in that evaluation is interdisciplinary research where a special relationship between theory and practice is established. On this regard, González [28] states that –in methodological terms– "to evaluate is to research" in the strictest sense of research, that is, to know an object of reality in all its space-time complexity, in all its aspects and interactions, and to generate a model of that object to describe it, explain it, interpret it, confront it with reality, and eventually be able to make predictions about it. This means that an ICT investment evaluation should not be conducted with closed eyes and limited to just following a method by the letter; it should be conducted conscientiously, with great rigor and care so that the evaluation team cannot just collect "some" information but "reliable and useful" information, and for this they need to be aware of what information is needed and from where it can be collected.

Based on all the aforementioned, one can state that evaluation, seen as a process, can be assigned the same definition as given by Hernández, Fernández, and Baptista [36] for the concept of research, which is: "a set of systematic, critical, and empirical processes that are applied to the study of a phenomenon." As such, methods for the evaluation of ICT investments can be based –similar to research methods– on numerical measurement and statistical analysis (quantitative approach) or on data that cannot be numerically measured (qualitative approach), with the former focusing on benefits of tangible nature and the latter focusing on benefits of intangible nature.

The evaluation of ICT investments can be "mixed" when it focuses on benefits of both tangible and intangible natures. In fact, Willcocks [104] defines that "evaluation is about establishing by quantitative and/or qualitative means the worth of IT to the organization."

In terms of the timing of the evaluation, it is suggested that there are two key points at which the contributions of an ICT investment can be evaluated [21]: a) prior to its implementation (*ex ante*) and b) following its implementation (*ex post*), understanding "implementation" as the interval between the first time the ICT investment goes into production and the point in time when decision makers decide that the investment has been in production for a period of time which is reasonable and sufficient to evaluate results [15], [56].

A common problem in evaluating a project is that priorities sometimes differ between investors, executives, and the evaluator. It is what distinguishes us as human beings: to be different by our level of expectations, degrees of aversion to risk, or information that we handle [88]. This differentiation can also be reflected in diverse strategies and strategic goals as these may vary according to a situation and a group's features [34]. This applies to any kind of project, including ICT investments, and thus the person in charge of the evaluation of a specific ICT investment should first recognize the strategy implemented by the investing firm and the strategic goals defined for the implementation of the specific ICT investment, in order to determine how its evaluation should be conducted.

The process of evaluation concerns how the evaluation is conducted (the methods and techniques used to mediate it), and it is strongly influenced by the context within which it is performed and, as such, it can be viewed as the institutionalized behavior of the evaluation participants [91].

B. Decision Makers in ICT Investments.

For this study, a decision maker in a firm is defined as a person who makes important decisions regarding ICT investments, namely decisions which are of great significance or value. These investments are part of planned changes that intend to fulfill needs, requirements and/or business strategies in their organizations.

Changes in a firm may be planned in the form of an investment project, which is defined as a technical and economic proposal to solve a problem of the society by using available human, material, and technological resources [23] for the achievement of expected results expressed in benefits for

the group of people positively affected [87], who –in the context of this study– would be all individuals in the ICT investing firm who benefit directly from the use of the technology implemented.

Certo and Certo [12]define decision making as "the process of choosing the best alternative for reaching objectives," and this process is attributed to the managers of an organization. In fact, managers get paid to make decisions that affect their organization daily, and they must communicate those decisions to other organization members. Additionally, according to Reynolds [83], managers must lead the effort to pursue information technology policies that best meet organizational needs, and in order to do so they must understand said technology and lead the decision making regarding ICT investing and usage. This suggests that managers are responsible of leading decision making –including that related to ICT investments–, communicating decisions within their organization, and guaranteeing that their organizational needs are met with those decisions.

Decision making is also defined as "one of the essential components of management which appears in all management tasks" [62] and "one of the biggest challenges to the managers of an organization" [96]. Some authors consider that management is decision making [2], [17], [43], [97].

Decision making involves more than choosing among available courses of action [71] –which may also include inaction. It involves making decisions about the decision process itself [96]. It is a process involving choices, and the process generally consists of several steps: identifying problems, generating alternatives, evaluating alternatives, choosing an alternative, implementing the decision, and evaluating decision effectiveness [59]. Confident decision makers have an uncanny sense of timing, they know when to make the decision and how to make it effectively; they know when to let someone else make the decision, that is, they have the courage –and the means– to delegate; they have the ability to live with ambiguity; and, finally, they have the courage to act [16].

Within this context, it is reasonable to believe that managers –especially upper-level ones– would be responsible for decision making in ICT investments. Therefore, and taking into consideration that investing in ICTs can be considered as a goal-oriented decisional process [57] and that as such it would be of strategic nature and directed to affect specific departments or functions within an organization, decision makers can be described as the group of managers who are in charge of the specific departments or functions that are affected by an ICT investment in an organization, who for the purpose of this study will be defined as "key managers." Based on this definition, it is considered that the Chief Information Officer (CIO) –or the person in charge of managing the organization's ICT strategy– would always be a key decision maker to be taken into account due to: a) the CIO's role as internal provider of technological services to user departments [29], and b) the CIO's recent evolution to a more strategic and executive-level position in organizations [14], [89], [99]. Additionally, regarding the evaluation of ICT investments, user managers and CIOs have been considered as the most relevant groups for evaluating operational efficiency and effectiveness [60].

C. Tangible and Intangible Benefits.

Investing in ICTs provides firms with important benefits which are not restricted to those of tangible nature and easily quantifiable, but can also include benefits of intangible nature, which are difficult to measure [4], [42], [67], [94].

The endeavor of clearly identifying benefits obtained from ICT investments in firms has led to the need to distinguish between tangible and intangible benefits. Many authors have dealt with this problem and several comparisons have been proposed, such as the following:

- Benefits are set out in terms of "soft" and "hard" benefits. Soft benefits are intangibles such as better information or improved staff morale. Hard benefits are measured in cash, at least in theory [4].
- A tangible benefit is one that directly affects the organization's bottom line and an intangible benefit is one that does not. An intangible benefit has an indirect impact on the organization's productivity and performance [79].
- A tangible benefit can be defined as one that directly impacts an enterprise's bottom line, such as a direct cost savings or revenue generation. The intangible variety is one that brings about improvement in business performance, but not in a way that directly impacts the bottom line. An example of this would be one that improves management information or the security of the firm [68].
- A tangible benefit is one with direct financial consequences that are easily measurable, while an intangible benefit has indirect financial consequences that are either not measurable or only able to be estimated or modelled approximately [75].
- A tangible benefit is concrete and can have a direct measurement of its value. In contrast, an intangible benefit cannot be definitively described by a quantitative value [33].
- A tangible benefit can be measured directly and assigned a monetary value. In contrast, an intangible benefit cannot be measured directly or quantified easily in terms of money, time, or frequency, or by using mathematical equations [56], [82], [101].

These authors share common attributes on which they base their comparisons between tangible benefit and intangible benefit: type of benefit, ease of measurement, and type of impact on an organization's bottom line (which includes productivity, performance, and finances). Table I summarizes these comparisons from which we can conclude that "*a tangible benefit is a hard benefit which is easy to measure, while an intangible benefit is a soft benefit which is difficult to measure; additionally, an organization's bottom line (productivity, performance, and finances) can be directly impacted by a tangible benefit, but indirectly impacted by an*

TABLE I
SUMMARY OF COMPARISONS MADE BY CITED AUTHORS: TANGIBLE BENEFIT VS. INTANGIBLE BENEFIT

Attribute	Tangible Benefit	Intangible Benefit
Type of benefit	Hard	Soft
Ease of measurement	Easy	Difficult
Type of impact on an organization's bottom line	Direct	Indirect

intangible benefit." However, the most noticeable difference between tangible and intangible benefits seems to be that tangible benefits can be easily expressed in terms of monetary profit, while it is a challenge to express intangible benefits in such terms.

D. Value Contribution of ICT Investments to Firms.

Value can reflect the perceived tangible and intangible benefits [52]. Intangible benefits are value sources of intangible gain [56]; analogously, tangible benefits are value sources of tangible gain. This suggests that the value contribution of ICT investments to firms derives from all benefits –tangible and intangible– obtained from the same.

Adopting ICTs in firms has proven positive effects in multiple aspects, such as: process flexibility, work productivity, profitability, sales, production costs, product quality, teamwork effectiveness, and organizational environment. In some cases it was found that a firm's performance is directly proportional to their level of adoption of ICTs [65]. In fact, technology can be represented in any of the activities of a firm's value chain [78], and it is therefore reasonable to believe that ICTs can be an important factor in firms' process execution and performance.

Examples of ICTs value creation in firms can be in process planning and support improvement; supplier linkages; increased company innovativeness, and in improving customer relationships as they can result in an increase in market share [98]. ICTs can significantly impact the market-oriented dimensions of products and services as well as manufacturing processes, working practices, and management practices [84].

The literature also provides with empirical evidence of the positive effect of ICTs on firm performance in terms of productivity, profitability, market value, and market share, as well as on intermediate performance measures, such as process efficiency, service quality, cost savings, organizational and process flexibility, and customer satisfaction [6].

ICTs can allow firms to gain competitive advantage: a) in cost by altering cost drivers of activities in ways that can improve (or erode) a firm's relative cost position, b) in differentiation by customizing products, and c) by exploiting changes in competitive scope [77].

Firms have also found benefits in using technology to differentiate their offerings in the market, reduce costs, and improve service delivery and management/operational processes [12], [44], [63], [66], [73]. ICTs may allow firms to achieve a differentiation advantage by securing relationships with customers through better quality and greater ability to respond rapidly to market changes [6].

Business managers use technology to integrate individual, group, departmental, and corporate communications [53]. ICTs have contributed to the development of integrated marketing communications [32], which are the means by which firms attempt to directly or indirectly inform, persuade, and remind consumers about the brands they sell [49]. Integrated marketing communications are considered an important contribution to brand equity building [92], [93]; therefore, ICTs have been a contributing factor to brand equity building in firms. ICTs, such as intranets, can enhance an organization's business strategies [53] and provide with intra-organizational communication at reduced cost by allowing employees to distribute and communicate their ideas more readily, thus positively impacting organizational performance [98].

According to [90], some benefits that may be obtained from the adoption of ICTs in firms are: increase in performance, strength from the use of computer networks, ability to adapt and innovate, and improvement of productivity. Additionally, with the adoption of ICTs a firm should obtain for the handling of their information: reliability, efficiency, effectiveness, compliance with current legislation, confidentiality, integrity, and availability. Other value added outcomes that may be obtained are: information search and knowledge acquisition; effective communications; transaction efficiency and effectiveness; problem-solving capability; monitoring, evaluation, and control; improved working practices; and relationship development [84].

ICTs can therefore be an important factor of benefit at all levels in an organization, no matter its size. As per the literature reviewed, not only employees use technology at operational level but also managers use it at strategic level; thus, ICTs can be represented in any of the activities of an organization's value chain. It is important to remark, however, that the total value contribution of ICT investments to firms would not derive from the mere implementation of said technologies. Even though one could agree that ICTs make work life easier and that the simplification of task execution can be perceived as an immediate benefit of their mere implementation, the evaluation of the total value contribution of ICT investments to firms should also consider the results of the combination of ICT's technical characteristics and advantages with user beneficiaries' capacities and skills.

E. Value Contribution of ICT Investments to User Beneficiaries.

Investments in ICTs can result in benefits not only at firm level but also at user beneficiary level. A user beneficiary is a person who benefits from the use of the technology implemented in their business unit with an ICT investment project [57], that is, a member of an organization who makes direct use of said technology for the execution of daily activities.

The implementation of ICTs can allow individual employees to perform their current tasks at a higher level, assume additional tasks, expand their roles in the organization due to advances in the ability to gather and analyze data (these benefits would result in information efficiencies at firm level), pool their resources, and cooperate and collaborate across role

or subunit boundaries (these are between-person or between-group effects that would result in information synergies at firm level) [20]. This is consistent with the definition of Day, Paquet, Scott, and Hambley [18] who affirm that ICTs can: a) enhance user beneficiaries' ability to solve problems by increasing their access to information and b) improve their performance efficiency by increasing their ability to communicate with other members of their organization.

According to Day, Paquet, Scott, and Hambley [18], the impact of ICTs on employees' outcomes is a function of the extent to which ICTs: a) influence the accessibility of employees to their workplace and colleagues, b) influence employees' access to information, c) impact on communications with others, d) are implemented as a means of monitoring employees' performance and providing feedback, and e) impact employees' control over their work and home life. In fact, portable ICT devices can enable user beneficiaries to complete work even when they are not physically at their workplace, meaning an increase in their accessibility to information and their availability and capability to respond to their customers' and superiors' demands. ICTs can increase information and accessibility both at work and away from the workplace, increasing the frequency and ease of communication among employees [18], [76].

Even though previous studies suggest that ICTs may have a negative effect on users' productivity [3], [69] (or even work-life interaction [19]) and that many employees see ICT adoption as a complication of their jobs [6], it is well accepted in the literature that ICTs contribute to improve work efficiency and to make work life easier –and thus improve productivity– by enhancing the internal flow of communication, optimizing the information exchange between employees, or accelerating coordination processes with customers [18], [69].

Additionally, ICTs can contribute value to the quality of a firm [6], [65] as a result of their implementation in the firm's processes. Taking into consideration that employees have individual responsibilities in the execution of process activities and that for that they may be able to benefit from the use of ICTs, it would be reasonable to believe that ICTs can contribute value to each employee's work quality. Thus, employees work together to make a collective contribution to quality [46], and said collective contribution would result from the sum of the individual quality contributions of employees, which may be potentiated by the use of technologies.

F. On Methods and Techniques for Evaluating ICT Investments.

The literature reviewed provides with information on methods and techniques proposed for the evaluation of ICT investments which we can classify in two categories: a) evaluation methods based on an approach on tangible elements and b) evaluation methods based on an approach on intangible elements.

Evaluation methods based on an approach on tangible elements include:

- Return On Investment (ROI). There are three commonly used methods based on return on investment: net present value, discounted cash flow, and payback period. Such methods are designed to measure the hard, quantitative, monetary impact of capital investment. Methods based on return on investment are generally regarded as more theoretically correct and practically feasible approaches to capital investment appraisal. Such methods are also commonly accepted in many organizations as the standard basis for selecting capital investment projects [94]. Methods based on return on investment are considered as capital budgeting techniques that provide with a single score or statistic by which to assess the investment (or compare competing investment options) [80]. Therefore, these methods have their limitations based on the fact that they focus only on tangible elements and seem not to be viable to be exclusively implemented in conducting a comprehensive evaluation of ICT investments which requires multidimensional measurements that must integrate tangible and intangible elements [31], [45], [54], [74]. ROI methods are unable to capture many of the intangible benefits that ICTs bring to an organization [94].

- Cost-Benefit Analysis. This analysis tries to overcome the problem of methods based on return on investment by finding some surrogate measure for intangible costs or benefits, which can be expressed in monetary terms. The approach attempts to deal with two problems: (1) the difficulty of quantifying the value of benefits that do not directly accrue to the investor in the project, and (2) the difficulty of identifying the benefits or costs that do not have an obvious market value or price (*i.e.*, intangible factors). Therefore, the cost-benefit analysis method is useful when the costs and benefits are intangible, but the method requires the existence of a broad agreement on the measures used to attach a value to the intangibles [94]. Cost benefit analysis is also based on using money as a metric for combining many factors, some of which are distinctly non-monetary in origin [80]. This method has limitations based on the fact that not only all costs and benefits are not always easy to identify and measure, but they also do not occur at one point in time but rather follow a dynamic path, which makes it necessary to define a discount rate in order to compare cost and benefits which occur in the future with those which occur now [40]. Additionally, technical limitations may make it impossible to quantify and then monetize all relevant impacts as costs and benefits [9].

- Return On Management. In this approach all measures of productivity use the simple ratio of output/input. Management's output is defined as management's value-added, which is everything left after subtracting all the direct operating costs from the value added due to direct labor [94]. Return on management is based on a value added approach that isolates the management added value and then divides this by the management

cost [81]. The advantage of methods based on return on management is that they concentrate on ICT's contributions to the management process; however, they have limitations based on the fact that the residual assigned as the value added by management cannot be directly attributed to the management process [81], [94].

- Information Economics. This is a variant of cost-benefit analysis, tailored to cope with the particular intangibles and uncertainties found in information systems projects. However, the decision making process used in this methodology is based on a ranking and scoring technique of intangibles and risk factors associated with the ICT investment. It identifies ICT performance measures and uses them to rank the economic impact of all the changes that introduction of the ICT generates in an organization's performance. Here, also, surrogate measures are often used for most intangibles and risk factors that are hard to estimate. The strength of the Information Economics method is that it links the quantification and comparison approaches with qualification approaches [94]. This method is based on a composite approach as it combines several fundamental measures to get a "balanced" overall picture of value/investment return. It may also be ad hoc as in conventional weighted ranking. Even where the structure is predetermined, different weighting and scoring schemes may be used to alter the balance of the factors affecting the decision. The ultimate output of this method may be a single number score [80]. Some limitations are that it does not deal with the mechanism but only with its outcomes, and that it focuses on simple, idealized settings that can be modeled with applicable mathematical models, often requiring many simplifying assumptions [80], [94].

- Total Cost of Ownership. This method consists of a procedure that provides the means for determining the total economic value of an investment, including the initial capital expenditures (CapEx) and the operational expenditures (OpEx). In the context of cloud computing and especially from the provider's point of view (the datacenter), this method corresponds to the estimation of the costs required to build and operate a cloud infrastructure, including: server, software, facilities, support and maintenance, network, power, cooling, and real estate [24]. The Total Cost of Ownership approach is a measure often used to assess the effectiveness of an organization's ICT expenditures and supplier performance, more specifically efficiency, defined as the total quantity of resources (inputs) that need to be expended to obtain a given quantity of goods or services from a supplier (outputs). It is a holistic view of costs related to ICT acquisition and usage at an enterprise level [95], [102]. The Total Cost of Ownership approach is one of the most significant cost-oriented approaches that is widespread in research and practice alike and makes it possible to analyze the costs or individual cost components of an ICT artifact by means of a predefined scheme. It virtually constitutes a mathematical representation of the "real world". However, it is not its purpose to provide a 1:1 image of reality but to deliver a simplified, abstract view. Hence, instead of including all relevant costs into the analysis, the complexity of reality can be reduced by working on the basis of assumptions and by including only a limited number of carefully selected cost factors. In spite of this limitation to selected cost factors, this method should be able to provide reliable decision support [103]. Additionally, the complex calculations involved, and in particular the activity-based costing procedure for computing the cost of managing the relationship with a supplier, pose a major obstacle to widespread the implementation of this method [102]. This method seems to measure only one side of the process: the cost. Other methods can provide additional measures to complement for a multidimensional analysis.

Evaluation methods based on an approach on intangible elements include:

- A holistic approach by simulation. The approach consists of a number of steps that aim to transform an ill-defined problem into a set of generic, replicable actions that drive the evaluation effort. Such an approach is needed to codify experience and ideas, and to facilitate structuring, planning, and monitoring of future efforts. This approach is mainly targeted to business change scenarios where ICT applications and computer networks play an integral part. This method has its limitation based on the fact that it is suitable for investments that are expected to yield intangible and/or indirect benefits as opposed to hard or strategic ones. Simulation will not provide monetary data outputs and thus other methods such as Return On Investment or Cost-Benefit Analysis should be used for that end [25]. Therefore, this method seems not to be viable to be exclusively used to conduct a comprehensive evaluation of ICT investments which requires multidimensional measurements that must integrate tangible and intangible elements [31], [45], [54], [74].

- Multi-criteria analysis. This analysis is mainly directed to assess the acceptability and the value of ICT projects in the public sector, especially when the projects feature the qualitative value along with the monetary one. This approach is based on the possibility of recombining the following three ICT projects public value assessing methodologies: the American Value Measuring Methodology (VMM), the French MAREVA (*Méthode d'Analyse et de Remontée de la Valeur*), and the German WiBe (*Wirtschaftlichkeitsbetrachtung*). The analysis features the value acceptability threshold as an indicator of improvements in case of the implementation of a project and as a tool for eliminating projects whose contribution to value is too low. While this approach may allow assessing: a) tangible costs and benefits, b) intangible cost/benefit ratio, and c) the structure of risk and its influence on costs and the value of an ICT project, the three methodologies mentioned (VMM, MAREVA, and WiBe) are originally intended

for their use in decision-making in the public government sector when ICT projects are being chosen [47]. Therefore, this approach has limitations based on the fact that it is intended for assessing ICT investments in the public government sector at the *ex ante* stage. This means that this approach is limited to the *ex ante* stage where an ICT investment is not yet implemented and therefore benefits are yet to be obtained; it does not take into consideration the *ex post* stage where benefits can be evaluated. Additionally, objectives pursued with the implementation of investments in the public sector differ from those in the private sector in that the former seek to meet social needs and the latter seek to generate wealth for a private organization. In view of this, the definition of "benefit" itself will differ between both sectors.

- Examination of intangible outputs such as innovation. This approach involves further analysis of the impact of information technology on innovation output. This includes an examination of unique time periods, returns to ICT capital in ICT-using versus ICT-producing industries, and the contribution of ICT to highly valued, blockbuster innovations [50]. This approach has limitations based on the fact that it is intended for assessing ICT investments at the *ex post* stage, so it should be complemented with an approach on the *ex ante* stage.

- Identification of difficulties –which may include intangible aspects– before and after adopting technologies. This method consists of identifying risks and difficulties of adopting technologies in an organization so as to detect opportunities for organizational improvement by developing activities that enable users to obtain better skills in the context of adopting advanced technologies [67]. This method has limitations based on the fact that in order to identify risks and difficulties it would be necessary to at least first define what levels and/or areas will be analyzed, that is, if the search for risks and difficulties will be conducted at the levels of process, personnel, investment stage, organizational structure, and/or any other, which implies complexity in the implementation of the method.

- Multi-Objective, Multi-Criteria. This method attempts to develop a general measure of utility, defined as the satisfaction of an individual's preferences. It is based on the belief that people's behavior is determined to some extent by the feeling that their preferences are recognized. This method is probably most applicable to complex projects that, additionally to attempt to meet the needs of many different users, contribute with benefits which are intangible. Using this method enables exploring the value of a set of system proposals in terms of relative preferences for different system features. The multi-objective, multi-criteria method is a semi-subjective method for appraising the value of different outcomes in terms of the decision makers' own preferences [94]. This method provides with the ability to reflect both tangible and intangible benefits, link the investment to business strategies, increase management participation in the evaluation process, and provide important features of portfolio selection; however, it has limitations based on the lack of a financial measure of profitability, the overall time requirements for management, and the persisting problem of valuing intangibles [48].

- Value Analysis. It emphasizes the value that ICTs provide to a firm, rather than costs. The method is based on the following three assumptions: (1) Innovation is value driven and not cost driven, (2) intangibles can be identified and subjectively assessed but rarely measured accurately, as surrogate measures are often used to satisfy the requirement for most inputs, and (3) individuals driven by cost and those driven by effectiveness will inevitably clash. The analysis begins with the observation that most successful innovations are based on enhancing value added rather than on cost savings. A multi-stage iterative process starts with a prototype system. Rather than developing extensive specifications, the analysis provides with simple models that can be expanded and modified until all complex aspects of the problem are included. Users are asked to provide the analyst with feedback on the values and limitations of the solution obtained from the prototype. The main difference between other ICT evaluation methods and value analysis is that the former methods directly aim at a final solution, while the latter uses an evolutionary process to get to a "satisfiable solution" which may be further improved [94]. With this method the value of the technology implemented rather than its cost is first assessed. This involves a careful study of exactly what the proposed technology will do and how the new functionality will affect the business [81]. Advantages of Value Analysis include: (1) quick identification of user requirements to establish agreed values for outputs, which would normally be classed as intangible; (2) improved communication between analysts and users, which gives decision makers some assurance that the benefits can be realized by means of prototype demonstrations; (3) incremental evaluation of benefits and costs, which enables management to continue the evaluation process or stop at any time; (4) an evolutionary approach, which results in user-tailored systems and (5) providing greater user satisfaction than traditionally developed systems. However, the method has several disadvantages: (1) establishing the required surrogate values and developing a prototype can be a long and costly process; (2) the method lacks an initial estimate of final costs and benefits, which may commit management to unexpected future expenditures; (3) without target estimates for "final solution values," existing program revisions can be significant [94].

- Critical Success Factors. This method explores the potential value of information systems involving comprehensive interviews with key managers to obtain their views about the business mission, objectives, and

current problems. It invites the analyst to explore together with executives the factors that are, in their opinion, critical to the success of the business, in particular the factors important for the functions or activities for which the executives are responsible. The executives can rank issues into levels of importance. The advantage of the method is that it provides a focus on the issues that are regarded as important by the respondents [94]. However, it has limitations based on the fact that the opinions of the key managers interviewed may be biased; additionally –as indicated in [94]– the method relies heavily on prototyping and pilot installations before proceeding.

Appendix I summarizes the characteristics and limitations of the methods and techniques for evaluating ICT investments listed in this paper. This should not be understood as a comprehensive list of existing methods since other existing methods may have not been covered by this study.

The literature reviewed proposes methods for evaluating ICT investments by approaching tangible or intangible benefits, and it analyzes cases where ICT investments are evaluated based on tangible benefits obtained [38], [64], [85]. However, the literature seems to lack of a systematic analysis on evaluations conducted based on intangible benefits. Methods proposed for evaluating benefits which are difficult to measure are perceived as too broad in scope, difficult and expensive to implement, or not very accurate or effective [61], [91], [94], [104]; this seems to lead decision makers to focus on quantifiable economic benefits while neglecting the analysis of intangible benefits.

References [4], [13], [42], [67], and [94] agree in that current evaluation methods which are commonly accepted do not provide with procedures to guide decision makers in the analysis of intangible benefits, and they focus on quantifiable economic benefits without taking intangible benefits into account. Recent studies dealt with this assumption by analyzing information gathered from the perceptual perspective of active employees [55] and from the perspective of decision makers [58] in connection with procedures and tools used for the evaluation of benefits obtained from the implementation of ICT investments in their organizations.

G. A Gap Between Theory and Practice.

Lindo [55] provided evidence that there exists a split perception of employees on the existence of procedures to evaluate ICT investments in their companies: one part perceived that such procedures exist and take into account tangible and intangible benefits; another part perceived that the evaluation of intangible benefits is important, but their companies do not have procedures therefor. Lindo [58] provided evidence that decision makers lack official procedures and tools for evaluating their ICT investments by analyzing benefits of both tangible and intangible natures; instead, each decision maker defines and implements their own procedures and tools by limiting their evaluation to the nalysis of tangible benefits while neglecting the analysis of intangible benefits. The evidence provided by both studies suggests that, in practice, decision makers focus their evaluation mainly on the analysis of tangible benefits and limit the estimation of intangible benefits to subjective judgments. Therefore, a gap between theory and practice [94] has been identified. Accordingly, this paper can be positioned as an instrument to organize and structure knowledge gathered from the literature review on the subject of evaluation of ICT investments and its components, which may provide basis for future studies which may aim to explore on opportunities to develop new methods for evaluating ICT investments, mainly with focus on intangible benefits in view of the identified gap.

III. RESEARCH METHODOLOGY

We conducted a qualitative study with exploratory and descriptive scope in order to derive a theoretical and descriptive perspective of the current situation regarding the knowledge area of the evaluation of ICT investments. For this end, a literature review was conducted exploring characteristics of the processes of evaluation and decision making (as related to ICT investments), descriptions of decision makers, definitions of tangible and intangible benefits, value contributions of ICT investments to firms and user beneficiaries, methods and techniques for evaluating ICT investments, and the actual existence and/or use of procedures and tools for evaluating ICT investments in organizations by integrating tangible and intangible factors.

The literature review was conducted following the stages of an analytical framework identified by Grant and Booth [30] with the mnemonic SALSA, which are: Search, AppraisaL, Synthesis, and Analysis. These stages are represented in Fig. 1.

The data collection instrument in the qualitative process is the researcher [37]; therefore, for this work we acted as the instrument for the immersion in the field of knowledge using as main sources published books (in printed and electronic formats) and papers (in electronic format) concerning the knowledge area.

A. Search and Appraisal.

We followed the stages of the search process: scoping search, conducting search, bibliography search, verification, and documentation [10]. We extracted and filtered from the collected literature references and evidence that we identified belonged or corresponded to the knowledge field of our interest (evaluation of ICT investments) and had precise or logical relevance to our research, thus being pertinent to our study. In other words, references and evidence were considered pertinent to our study if directly or indirectly contributed to form a theoretical and descriptive perspective of the current situation regarding the knowledge area of the evaluation of ICT investments and/or to build background theory for use in our study.

We repeated this cycle for obtaining references and evidence as deemed necessary, and we stopped when considered that we had reached theoretical saturation [26], which means that no additional information was being found that would significantly further our study.

Electronic books and papers were retrieved from the Internet by searching indexed databases including Google

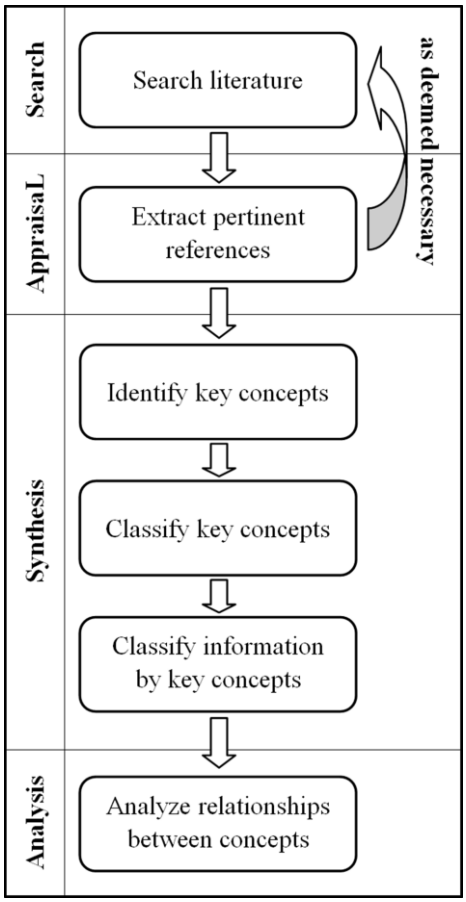

Fig. 1. Stages of the methodology used for this work based on an analytical framework identified by Grant and Booth [30] with the mnemonic SALSA.

Scholar, Google Books, ScienceDirect, ACM Digital Library, CiteSeer^{X}, IEEE Computer Society, Directory of Open Access Journals, as well as the IT Governance Institute and cross-references. We used the broad search terms (in alphabetical order) "decision maker," "evaluation," "ICT investment," "intangible benefit," "methods," "tangible benefit," "techniques," and "value contribution" for the first loop of the search. Subsequent loops were based on words and/or concepts derived from the prior loop. Examples of these are (in alphabetical order): "brand equity," "decision making," "differentiation," "efficiency," "investment project," "management," "performance," "productivity," "quality," "research," etc.

B. Synthesis.

In this sub-stage we synthesized the main ideas of the content of the selected literature that were relevant to our study by marking them with the following terms (in alphabetical order): "benefits," "decision makers," "evaluation of ICT investments," "firms," "gap," "methods/techniques," "practice," "qualitative," "quantitative," "theory," and "user beneficiaries." We then used these terms as key concepts that serve as the main conceptual support for the structure of our study.

C. Analysis.

We built a concept map beginning with "Evaluation of ICT investments" as the main concept and breaking it down into more specific pertinent ones by using the key concepts identified in the previous sub-stage. We connected the concepts using linking phrases and words in order to illustrate and examine the relationships between them.

Our concept map is shown in Appendix II. The main concept and the key concepts selected in the previous sub-stage appear shadowed. Linking phrases and words illustrate the relationships found among the concepts represented in the map.

IV. TEACHINGS OF THE SPECIALIZED LITERATURE REVIEWED

Some authors in the literature reviewed suggest that current evaluation methods which are commonly accepted do not provide with procedures to guide decision makers in the analysis of intangible benefits obtained from the implementation of ICT investments [4], [13], [42], [67], [94]. Other studies have presented empirical evidence that organizations lack clear procedures to guide decision makers in the analysis of said intangible benefits, and they focus on quantifiable economic benefits without taking intangible benefits into account [55], [58].

Evaluating ICT investments has been suggested to be similar to the research process in methodological terms. Thus, methods for evaluating ICT investments can basically be of quantitative or qualitative approach if they focus on tangible or intangible benefits, respectively. They can also be mixed if they focus on both tangible and intangible benefits. Additionally, the evaluation of said investments can be conducted *ex ante* or *ex post*, all this taking into account the strategy implemented by the investing firm and the strategic goals defined for the implementation of the specific ICT investment.

Previous studies suggest that the basic group of decision makers involved in the evaluation of ICT investments in an organization would be composed of: a) key managers (all managers in charge of the specific departments or functions that are affected with the investment) and b) the CIO (or the person in charge of managing the organization's ICT strategy). These are considered as the most relevant groups for evaluating benefits obtained from ICT investments, which can be of tangible or intangible natures. These benefits can be obtained not only at firm level but also at user beneficiary level. At firm level ICTs can contribute value to firms' brand equity, differentiation, efficiency, performance, productivity, and quality. At user beneficiary level they can contribute value to user beneficiaries' efficiency, performance, productivity, and quality of work.

Various methods have been proposed in the literature for evaluating ICT investments with focus on tangible benefits (quantitative approach) and with focus on intangible benefits (qualitative approach). However, the literature seems to lack of a systematic analysis on evaluations conducted based on intangible benefits. Many authors suggest that the methods proposed for evaluating benefits which are difficult to measure

are perceived as too broad in scope, difficult and expensive to implement, or not very accurate or effective, and this seems to lead decision makers to focus on quantifiable economic benefits while neglecting the analysis of intangible benefits.

Thus, the process of evaluation of ICT investments in firms should basically involve all managers in charge of the specific departments/functions that are affected with the investment and the person in charge of managing the organization's ICT strategy. This team would be in charge of deciding when and how the evaluation process should be conducted, taking into consideration the strategy implemented by the investing firm, the strategic goals defined for the implementation of the specific ICT investment, and methods available for conducting the evaluation which may include quantitative or qualitative approaches. In practice, however, even though the specialized literature proposes methods for evaluating ICT investments by using any of these approaches, decision makers tend to focus their analysis on quantifiable economic benefits and limit the estimation of intangible benefits to subjective judgments, which evidences the existence of a gap between theory and practice in the evaluation of ICT investments in firms.

V. Summary of the Study

The purpose of this study is to contribute to knowledge construction on the process of evaluation of ICT investments. For this end, it organizes and structures the teachings of the specialized literature reviewed. The study deals with characteristics of the process of evaluation of ICT investments and relates it to the research process in methodological terms; it also defines and identifies decision makers that should be involved in the evaluation process. A classification for methods of evaluation of ICT investments is suggested under two criteria: a) type of approach (quantitative, qualitative, or mixed), and b) timing of the evaluation (ex ante or ex post). Some methods proposed in the literature reviewed for the evaluation of ICT investments are also presented. However, it is not the intention of this paper to suggest that this is a comprehensive list of existing methods since other existing methods may have not been covered by this study. It is also not the intention of this paper to make a comparative analysis of the presented methods. Nevertheless, their identification, description, and classification (based on type of approach) and the empirical evidence provided in [55] and [58] helped to identify a gap between theory and practice in the evaluation of ICT investments that should be addressed.

This paper provides a basis for future work that may aim to contribute to the development of new methods, procedures, and/or tools that enable decision makers to estimate the intangible value impact of their ICT investments in a more precise, applicable, and cost-effective way, and thus reduce the identified gap.

VI. Conclusions of the Study and Recommendations for Future Work

There exists a gap between theory and practice in the evaluation of ICT investments. Even though the literature reviewed proposes various methods and techniques for evaluating ICT investments which include approaches on tangible and intangible elements, in practice decision makers seem to focus their evaluation mainly on the analysis of tangible benefits and limit the estimation of intangible benefits to subjective judgments, since they consider that the methods proposed for evaluating intangible benefits are too broad in scope, difficult and expensive to implement, or not very accurate or effective.

The analysis of intangible benefits tends to be neglected as decision makers lack a structured methodology or a well-defined framework that would enable them to conduct a comprehensive evaluation of their ICT investments by integrating both tangible and intangible factors. Future studies should seek to develop a well-defined method to provide decision makers with procedures and tools to analyze the impact in their organizations of intangible benefits obtained with their ICT investments. This would contribute to reduce the identified gap.

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APPENDIX I

Characteristics and limitations of the methods and techniques for evaluating ICT investments listed in this paper.

Type of approach	Method/ Technique	Characteristics	Limitations
On tangible elements	Return On Investment	• Designed to measure hard, quantitative, monetary impact of capital investment. • More theoretically correct and practically feasible approach to capital investment appraisal. • Standard basis for selecting capital investment projects. • Considered as capital budgeting technique.	• Focused only on tangible elements. • Not viable to be exclusively implemented in comprehensive evaluations of ICT investments. • Unable to capture many of the intangible benefits that ICTs bring to an organization.
	Cost-Benefit Analysis	• Finds some surrogate measure for intangible costs or benefits, which can be expressed in monetary terms. • Useful where the costs and benefits are intangible. • Based on using money as a metric for combining many factors, some of which are distinctly non-monetary in origin.	• Requires agreement on measures to attach a value to intangibles. • Requires defining a discount rate to compare future cost and benefits with those which occur now. • Technical limitations may make it impossible to quantify and monetize all relevant impacts as costs and benefits.
	Return On Management	• Measures of productivity use simple ratio of output/input. • Based on value added approach that isolates management added value and divides this by the management cost. • Concentrates on ICT's contributions to the management process.	• The residual assigned as the value added by management cannot be directly attributed to the management process.
	Information Economics	• The decision making process is based on a ranking and scoring technique of intangibles and risk factors associated with the ICT investment. • Identifies and uses ICT performance measures to rank the economic impact of all the changes that the introduction of the ICT generates in an organization's performance. • Surrogate measures are often used for most intangibles and risk factors that are hard to estimate. • Links the quantification and comparison approaches with qualification approaches. • Based on a composite approach. It may also be ad hoc. • The ultimate output may be a single number score.	• Does not deal with the mechanism but only with its outcomes. • Focuses on simple, idealized settings that can be modeled with applicable mathematical models, often requiring many simplifying assumptions.
	Total Cost of Ownership	• Provides the means for determining the total economic value of an investment, including initial capital expenditures and operational expenditures. • It is a holistic view of costs related to ICT acquisition and usage at an enterprise level. • Analyzes the costs or individual cost components of an ICT artifact by means of a predefined scheme.	• Instead of including all relevant costs into the analysis, it works on the basis of assumptions and by including a limited number of carefully selected cost factors. • Calculations are complex, in particular the activity-based costing procedure for computing cost of managing the relationship with a supplier. • Focused mainly on tangible elements, such as cost.
On intangible elements	A holistic approach by simulation	• Consists of a number of steps aimed to transform an ill-defined problem into a set of generic, replicable actions that drive the evaluation effort. • Mainly targeted to business change scenarios where ICT applications and computer networks play an integral part.	• Suitable for investments expected to yield intangible / indirect benefits as opposed to hard or strategic ones. • Simulation will not provide monetary data outputs and thus other methods should be used for that end. • Not viable to be exclusively implemented in comprehensive evaluations of ICT investments.
	Multi-criteria analysis	• Directed to assessing acceptability and value of ICT projects in the public sector, especially when projects feature qualitative value along with monetary one. • Recombines the American Value Measuring Methodology, the French MAREVA, and the German WiBe. • Features value acceptability threshold as an indicator of improvement in implementing a project and as a tool for eliminating those whose contribution to value is too low. • May allow assessing: a) tangible costs and benefits, b) intangible cost/benefit ratio, and c) the structure of risk and its influence on costs and the value of an ICT project.	• The American Value Measuring Methodology, the French MAREVA, and the German WiBe are originally intended for their use in decision-making in the public government sector when ICT projects are being chosen (*ex ante* stage). • Objectives pursued with the implementation of investments in the public sector differ from those in the private sector. Therefore, the definition of "benefit" itself will differ between both sectors. • This approach is limited to the *ex ante* stage where an ICT investment is not yet implemented and therefore benefits are yet to be obtained; it does not take into consideration the *ex post* stage where benefits can be evaluated.

Continuation of APPENDIX I

Characteristics and limitations of the methods and techniques for evaluating ICT investments listed in this paper.

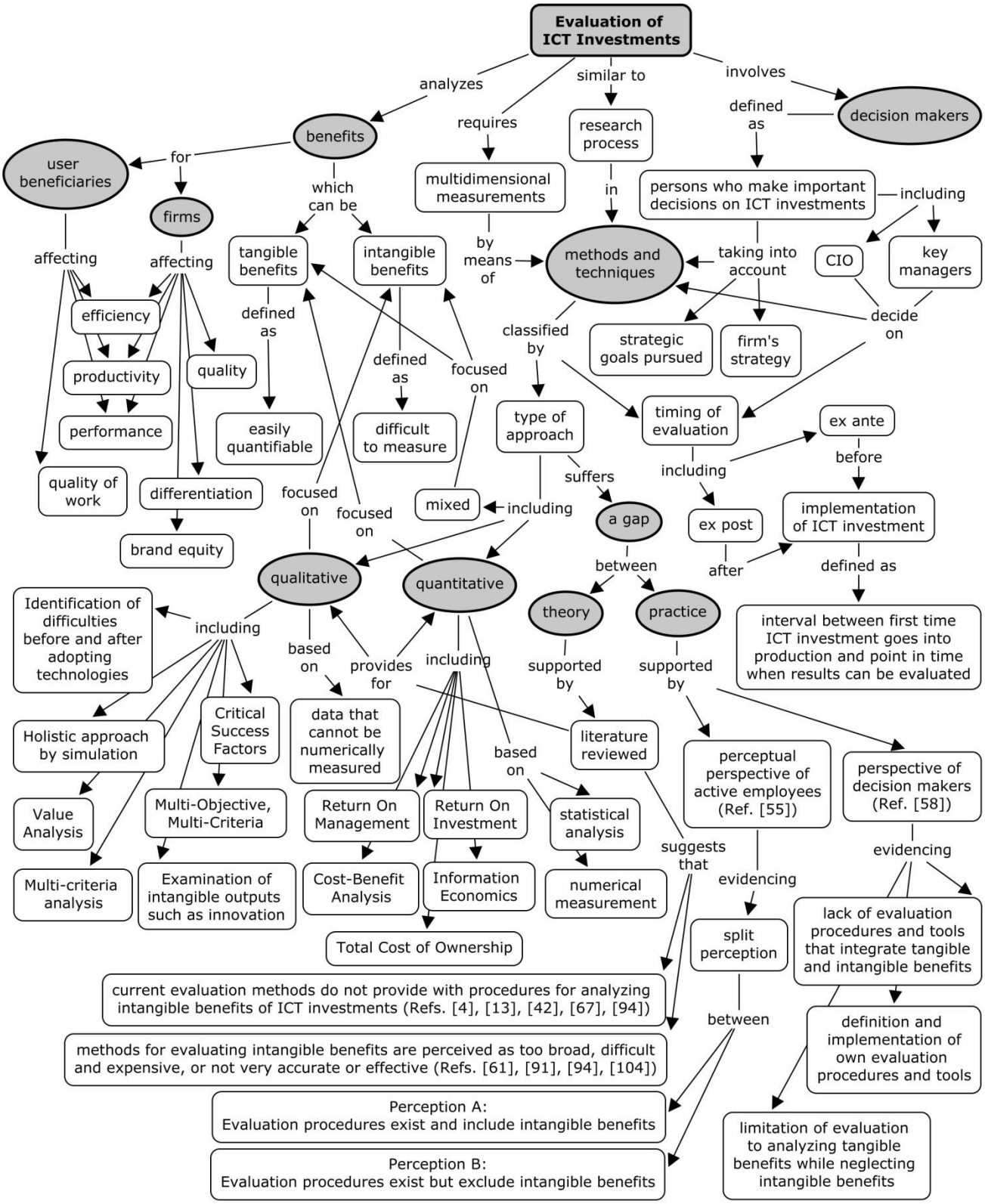
Type of approach	Method/ Technique	Characteristics	Limitations
On intangible elements	Examination of intangible outputs such as innovation	• Involves further analysis of the impact of information technology on innovation output. • Includes an examination of unique time periods, returns to ICT capital in ICT-using versus ICT-producing industries, and the contribution of ICT to highly valued, blockbuster innovations.	• Intended for assessing ICT investments at the *ex post* stage, so it should be complemented with an approach on the *ex ante* stage.
	Identification of difficulties before and after adopting technologies	• Identifies risks and difficulties of adopting technologies in an organization so as to detect opportunities for organizational improvement by developing activities that enable users to obtain better skills in the context of adopting advanced technologies.	• It would be necessary to at least first define what levels and/or areas will be analyzed in order to identify risks and difficulties. This implies complexity in the implementation of the method.
	Multi-Objective, Multi-Criteria	• Attempts to develop a general measure of utility, defined as the satisfaction of an individual's preferences. • Based on the belief that people's behavior is determined to some extent by the feeling that their preferences are recognized. • Most applicable to complex projects that, additionally to attempt to meet the needs of many different users, contribute with benefits which are intangible. • Enables exploring the value of a set of system proposals in terms of relative preferences for different system features. • Semi-subjective method for appraising value of different outcomes in terms of decision makers' own preferences. • Allows reflecting both tangible and intangible benefits, link the investment to business strategies, increase management participation in the evaluation process, and provide important features of portfolio selection.	• Lack of a financial measure of profitability, the overall time requirements for management, and the persisting problem of valuing intangibles.
	Value Analysis	• Emphasizes ICT value to firms, rather than costs. • Assumes that: (1) Innovation is value driven and not cost driven, (2) intangibles can be identified and subjectively assessed but rarely measured accurately, as surrogate measures are often used to satisfy the requirement for most inputs, and (3) individuals driven by cost and those driven by effectiveness will inevitably clash. • The analysis begins with the observation that most successful innovations are based on enhancing value added rather than on cost savings. • The analysis provides with simple models that can be expanded and modified until all complex aspects of the problem are included. • Uses an evolutionary process to get to a "satisfiable solution" which may be further improved.	• Establishing the required surrogate values and developing a prototype can be a long and costly process. • The method lacks an initial estimate of final costs and benefits, which may commit management to unexpected future expenditures. • Without target estimates for "final solution values," existing program revisions can be significant.
	Critical Success Factors	• Explores the potential value of information systems involving comprehensive interviews with key managers to obtain their views about the business mission, objectives, and current problems. • Invites the analyst to explore together with executives the factors that are, in their opinion, critical to the success of the business, in particular the factors important for the functions or activities for which the executives are responsible. • The executives can rank issues into levels of importance.	• The opinions of the key managers interviewed may be biased. • The method relies heavily on prototyping and pilot installations before proceeding.

Source: Literature reviewed.

Note: It is not the intention of this paper to suggest that this is a comprehensive list of existing ICT investment methods since other existing methods may have not been covered by this study. It is also not the intention of this paper to make a comparative analysis of the presented methods.

APPENDIX II

Concept map of evaluation of ICT investments.



Source: Literature reviewed.