



Beyond the Price Tag

Understanding the True Cost
of Digital Health Tools

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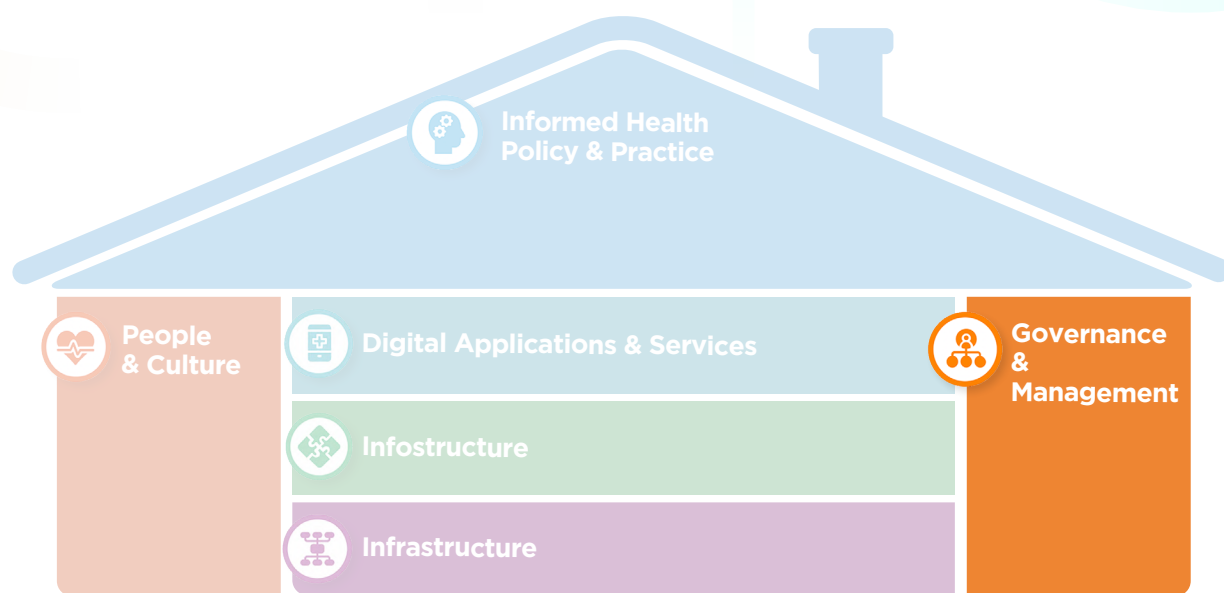
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Six key dimensions of digital transformation.

IBD Adaptation eHealth Architecture Model.

A well-defined approach to building the healthcare transformation pathway is critical not only to guide the journey itself, but also to inform the goals as it progresses. For this, the IDB uses the “digital house”.⁴ This encompasses the actions, products and investments necessary for a solid construction of the Digital Transformation, with good foundations, and integrates the different aspects and perspectives of the approach.

The digital house is made up of the six key dimensions: governance and management, people and culture, informed health policy and practice, infrastructure, infostructure, and sector digital applications and services. This publication is related to the **Governance and Management** dimension. For more information, check our publication [The golden opportunity of digital health for Latin America and the Caribbean](#).

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Executive summary

Total Cost of Ownership (TCO) is a cost calculation method that, when applied to the field of digital solution implementation, provides a final figure that reflects not only the cost of acquisition (buy, build or adapt) but also those related to the use, maintenance and closure of such solution. Total cost of ownership analysis is a financial estimate of all the costs—direct and indirect—of acquiring, commissioning, operating, maintaining and disposing of a product or system.

Public organizations, and to a lesser extent private organizations, do not usually calculate the total cost of digital health projects and, when they do, it is relatively easy for some of these costs to go unnoticed. When opting for a market solution, it is common to consider that the only cost is the license fee. On the other hand, if a development solution is chosen with its own personnel, the salary costs of the people who will carry out the project are not usually counted as project costs. Even less often are the costs related to change management considered.

The TCO calculation method, applied to the field of digital solution implementation, provides a final figure. This calculation takes into account the costs of the software itself, as well as the necessary hardware, hosting, maintenance and support. Calculating all the costs that will be incurred over the useful life of a system can be difficult, because it is easy to overlook key considerations and costs that occur during the life cycle of the project. In order to calculate the TCO of a digital health solution, the Inter-American Development Bank (IDB) has

developed a digital solution to help make the necessary calculations.

Technological solutions go through four phases: preliminary studies; acquisition, development and implementation; use and maintenance; and evaluation and closure. The proposed classification makes it possible to better identify the cost items, group them into categories, calculate the number of resources to be used and assign their value. The product of the number of resources by their value will indicate their cost.

The cost categories of a digital health solution are as follows:

- Internal human resources.
- External professional resources.
- Infrastructure.
- Licenses.
- Other operating costs.

To calculate the TCO of a digital health solution, the following steps should be followed:

- Identify the tasks for each phase of the project. For example, those corresponding to change management or infrastructure acquisition.
- Identify the cost items for each task. For example, licenses that will need to be purchased or network cabling.

- ➔ Calculate the number of resources to be used. For example, the working hours for each professional profile (category “internal human resources”) or the number of licenses to be purchased or contracted.
- ➔ Assign a value to resources. For example, the cost per hour of work for each internal professional profile, which corresponds to their annual salary plus social charges, divided by the number of working hours stipulated in their contract.
- ➔ Calculate the product of the number of resources by their value.

The final result is the sum of the costs of each item and each phase of the project.

Depending on the criteria of each organization, indirect costs should be added to this final result. The result may also be adjusted for inflation, for fluctuations in the exchange rate of the currency used in the calculation and for the social discount rate.

In no case does the TCO method offer an approximation of the benefits, effectiveness or utility expected from the implementation of the solution, nor does it provide analysis tools to help the decision-maker discern whether it is worth assuming the additional cost in exchange for greater benefit, effectiveness or utility. Nor is it a project management tool. This tool serves to calculate costs, information that is useful, even essential, for decision-making, but it should be noted that costs are not the only information to be taken into consideration (Cristia, J.P. and Vlaicu, R., 2022) (Bagolle, A. et al., 2022) (Blaya J., 2019).

1. Introduction

All healthcare systems in Western countries are in a difficult situation. In addition to the typical challenges of growing expenditure due to the aging of the population, increased frequentation of services, the incorporation of new technologies and citizens who are more aware of their rights (and therefore much more demanding in terms of the quality of the care they receive), there are the consequences of the COVID-19 pandemic.

The health crisis that began in 2020 has caused significant damage to primary health care systems and also to hospital performance.

The traditionally scarce resources dedicated to primary care were overwhelmed and, almost three years after the start of the pandemic, normality has still not been recovered, especially in those places where the shortcomings of this level of care can be considered structural (Galea, S., 2022) (Comunicado semFYC, 2022). Hospitals in Western health systems, which were on the verge of collapse, accumulate waiting lists, which in turn cause an increase in late diagnoses that can have important consequences for their patients (BMA. NHS backlog data analysis, November 2022). This situation is even more serious in those health services whose waiting lists are structural.

All this leads to the need to transform healthcare services by incorporating digital health as a means of improving the quality, efficiency and effectiveness that the above-mentioned challenges demand. As budgets are finite and priorities must be defined, all projects, including digital health projects, must be subject to cost analysis, including opportunity cost.

During the last few years, the idea that health systems should be transformed by taking advantage of the opportunity provided by information and communication technologies (ICT) has been consolidated (OECD, 2010) (Carnicero, R. et al, 2019) (Bagolle, A. et al, 2022). This is because any healthcare activity is very intensive in information processing. ICTs bring improvements in the efficiency and quality of the management of health system operations because they can reduce the operating costs of clinical services, decrease those of administrative services and transform healthcare. The implementation of information technologies can lead to higher quality care that is safer and more responsive to patients' needs and, at the same time, more efficient (appropriate, available and less costly).

The purpose of transforming healthcare systems can be none other than the search for a virtuous circle based on continuous improvement through the incorporation, also continuous, of new knowledge. The aim is to ensure that healthcare systems become Learning Health Systems (LHS) in which advances related to science, ICTs and knowledge derived from healthcare itself generate new knowledge. Achieving this digital transformation is only possible when ICTs are incorporated into the value chain of the health system, because improving quality, efficiency and effectiveness requires the health system to focus on the needs and preferences of the patient in a personalized way and not the patient in the abstract (Carnicero, R., 2019) (Porter, 2013).

Focusing on patient needs in a context of budgetary constraints requires that decisions be made after analyzing their costs and opportunity cost. However, most public systems are not known for calculating their costs with the necessary precision, because their budget-based management system only takes into account the cost of acquiring technologies, i.e. equipment, licenses and, where appropriate, consulting or other external services. In the vast majority of ICT procurements, CFOs rarely, if ever, build a complete cost model to independently project the total life-cycle costs of the entire project (Katalus, 2012) (McConalogue, E., 2019) (Eastaugh, S.R., 2013) (Johnson, L., 2019). Less common still is the calculation of the benefits in monetary terms of the advantages of a digital solution.

The purpose of this paper is to describe the application of the Total Cost of Ownership (TCO) method to digital health projects so that this important information can be taken into account when making decisions on the allocation of resources in health systems and services. This learning document is complemented by an [interactive online tool](#) that allows the calculation of the TCO of a digital solution, applying the concepts detailed herein. This tool allows to define different scenarios for the implementation of digital health solutions, calculate their costs and compare the results of the analysis to inform decisions and investments in digital health.



Click here to access
the online tool

2. Cost basics and total cost of ownership (TCO) concept

Health service managers may need to correct their decisions on digital health projects. . In addition to not fully calculating their costs, some mistakes are frequent such as those indicated below (Carnicero J., 2014):

- ➔ **Oversimplification** of the problem, with statements such as “we buy a market solution and that’s it”.
- ➔ **Disengagement**, “IT is a matter for the IT guys” or “to each one his own, we’d better outsource IT”.
- ➔ **Overestimation** of ICT’s possibilities, “this program will generate enormous savings”.

All these mistakes are related to the misjudgment of project costs. The assumption that the purchase of a market solution does not involve adaptation, integration and support work, among others, is totally erroneous. In summary, it can be stated that the price of licenses is only the first in a chain of costs that accompanies any digital health project.

In digital health, there is no such thing as a “turnkey” project, because all of them require the organization to carry out, at least in part, some tasks that are essential for the success of the project with its own resources. On the other hand, outsourcing IT services may be a wise strategy depending on the circumstances, but it always entails the need to allocate own resources, which must also be calculated, for tasks such as supervision of external services, among others. In the case of outsourcing services, employee relocation costs are incurred, which also need to be calculated.

Although the improvement in efficiency provided by ICTs is a consequence of improvements in quality, it is more than doubtful that it will lead to savings, or at least a reduction in spending, even if unit costs can be reduced, since in public health services the tendency is always to reallocate resources from efficient areas to other projects or improvements. Therefore, spending always tends to grow.

It should also be noted that any provision of equipment and software supposedly free of charge always entails costs for the organization, since they are accompanied by hidden costs linked to the price of products or services purchased by the hospital or health organization. For example, the integration costs of the supposedly free clinical analysis laboratory management software that accompanies the also supposedly free autoanalyzers. Moreover, this supposedly free service is always conditional on the exclusive purchase of reagents from the company that provides the software and hardware, at a price that is not very advantageous for the health center. Even free software transfers between public entities always have adaptation, integration and training costs (Himmelstein, D.U., 2010) (Miller, H., 2018) (Eastaugh, S.R., 2013) (Davis, D., 1985).

All of the above shows the importance of calculating the TCO whenever digital health projects are analyzed. In order to calculate the TCO of a project, basic cost concepts must necessarily be taken into account.

>> 2.1 Cost basics

Direct cost



A direct cost is one that directly originates the product or service. For example, a hip prosthesis is a direct cost because it is directly assigned to the product “Orthopedic surgery intervention. Replacement of hip prosthesis”. In the case of a digital health solution, hardware and software that are acquired for that digital solution are, for example, considered direct costs.

Indirect cost



An indirect cost is one that is not directly attributable to the product or service. For example, the cost of electrical energy in the surgical block is considered indirect, unless there are meters for each area of the hospital that also allow the energy consumption of each surgical procedure to be measured. In the case of a digital health solution, and for the same reasons, the energy consumption of the data processing center is also an indirect cost.

Fixed cost



A variable cost is one that changes according to the product (activity performed). The hip prosthesis is an example, because for a second operation another prosthesis will be used, not necessarily of the same price, and so on. Other variable costs of the surgical block are medicines, consumables and laundry of operating room linen. A variable digital health cost is the licenses whose price depends on the number of workstations where they are installed.

Variable cost



A variable cost is one that changes according to the product (activity performed). The hip prosthesis is an example, because for a second operation another prosthesis will be used, not necessarily of the same price, and so on. Other variable costs of the surgical block are medicines, consumables and laundry of operating room linen. A variable digital health cost is the licenses whose price depends on the number of workstations where they are installed.

Opportunity cost



When a decision must be made, the first step is to identify the different options that exist in order to adopt the most appropriate one. The opportunity cost is the cost of the option that is discarded, including its possible benefits. In this case, the cost is considered to be the “avoided benefit”, i.e., the benefit that the organization would obtain if resources were allocated to the best alternative. The opportunity cost of a hospital information system (HIS) may be the acquisition of a Positron Emission Tomography (PET) machine.

>> 2.2 total cost of ownership concept

The TCO method comes from the field of defense and homeland security.

It was adapted to the business world by the Gartner Group, who defined it as:

➡ ***“The total cost of acquiring, using, managing and retiring an asset over its entire life cycle.”***

(Manutan, 2020)

This method, applied to the scope of the implementation of digital solutions, provides a final figure that reflects not only the acquisition cost, but also those related to the use, maintenance and closure of such solution.¹ In other words, total cost of ownership analysis is a financial estimate of all the costs—direct and indirect—of acquiring, commissioning, operating, maintaining and disposing of a product or system. This calculation takes into account the costs of the software itself, as well as the necessary hardware, hosting, maintenance and support.

Calculating all the costs that will be incurred over the useful life of a system can be difficult, because it is common to overlook key considerations and costs that are incurred during the life cycle of the project. For example, the costs of maintaining and evolving a digital health solution are often overlooked. When projects are based on in-house development, the costs of the technicians responsible for development and implementation are often overlooked, and

maintenance and support costs are often overlooked as well. In short, the TCO calculation makes it possible to express in monetary units the economic effort required to implement a digital solution. It is a way of expressing a project in numbers, which allows, according to William Thomson (Lord Kelvin), to begin to know it (Thomson, W., 1893).²

In no case does the TCO method offer an approximation of the benefits, effectiveness or utility expected from the implementation of the solution, nor does it provide analysis tools to help the decision-maker discern whether it is worth assuming the additional cost in exchange for greater benefit, effectiveness or utility. Nor is it a project management tool.

This tool is used to calculate costs, information that is useful, even essential, for decision-making, but it should be noted that costs are not the only information that should be valued. Other important factors to be appreciated are functionality, ease of use, local infrastructure, existing systems, availability of engineers or consultants for software maintenance and user support, and the contribution of digital health projects to the local economy, among many others (Witonsky, P., 2012). In summary, for decision-making it is important to contrast the TCO with the gain obtained in quality and money.

TCO, like any other method for cost analysis, is based on the development of three steps:

- ➡ Identification of cost items.
- ➡ Determination of the number of resources to be consumed.
- ➡ Assignment of a value to each of the resources consumed.

¹ Acquisition refers to in-house development, the purchase or adaptation of commercial solutions, and the development or adaptation of open source solutions, among other strategies aimed at having a digital solution.

² “When you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.”

The identification of cost items consists of defining the elements that will consume resources. Since unforeseen cost items may arise during the course of the project, it is important to develop a list at the outset that is sufficiently comprehensive and flexible to include all costs that may arise.

The main added value of the TCO method with respect to others lies precisely in this first step, because it places the emphasis on identifying a list of cost items that goes beyond those related to the acquisition of the solution, to also consider all those that appear during its useful life and its replacement. In this way, the list of items contributes to the calculation of a final cost figure much closer to the real one than that offered by other methods. Examples of cost items are personnel hours, leave or travel during project execution. The items are grouped into homogeneous categories to facilitate their calculation.

Once the items have been defined, the cost calculation methods must focus their efforts on determining the amount of resources that will be consumed by each of them throughout the project. For example, it is a matter of estimating how many licenses will be needed or how many hours of each professional profile are required to adequately perform the tasks necessary for a correct development and start-up.

The third step is to assign a value to each of the resources. For example, the cost in monetary

The TCO method IS:

- ✓ A costing tool.

The TCO method IS NOT:

- ✗ An economic evaluation method.
- ✗ A project management tool.
- ✗ A budget preparation and management tool.
- ✗ An analytical accounting or cost accounting system.
- ✗ A tool that alone can be used to choose between buying, adapting or developing a digital solution.

units of one hour of work of a developer. In this way, the cost item is the developer profile, the number of hours they will spend on the project is the amount of resources of that item and their value is the cost of the hour. Therefore, the number of hours times their cost is the total cost of the developer on the project.

3. Phases, categories and cost items

As indicated above, it is necessary to define all the cost elements to be considered when applying the TCO method to the acquisition of technological solutions in the health sector and in other areas of social policy. To this end, it is necessary to define the different phases that the life cycle of technological solutions goes through and to identify all the cost categories that serve to group the different items that may be present in each of these phases.

This section describes all these elements and also shows the cost items that should be considered regardless of the possible strategies for acquiring the solution:

- ➔ build the solution from scratch,
- ➔ adapt an existing solution
- ➔ or buy an already developed product (buy, build or adapt),
- ➔ among other possibilities.

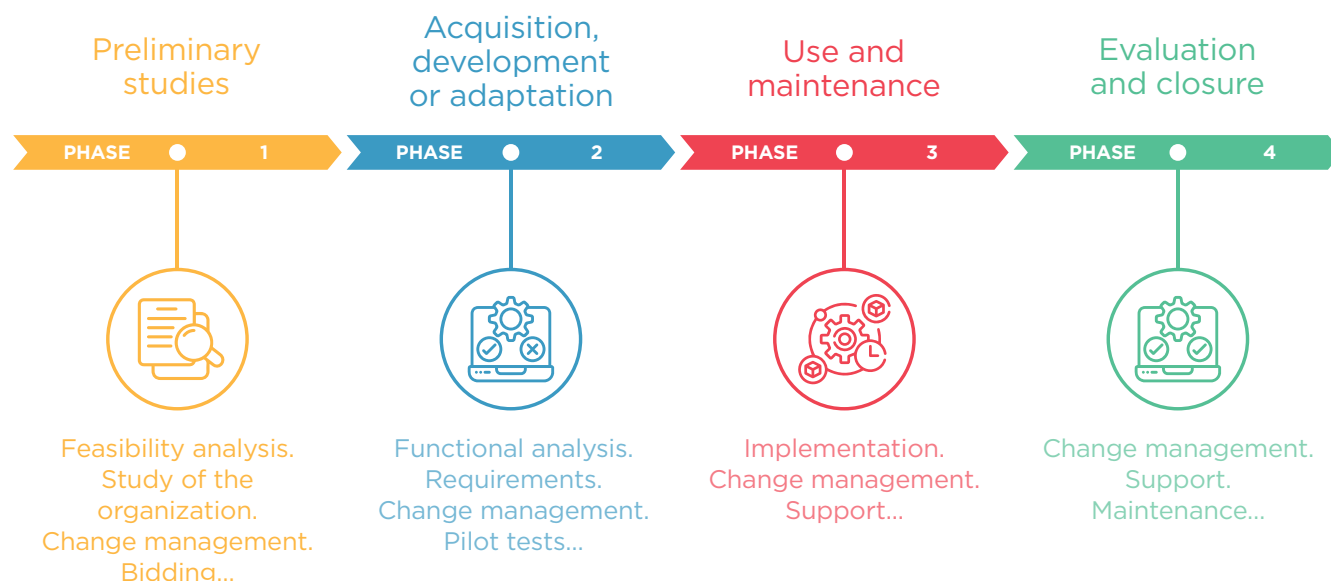
The various software as a service (SaaS) options are considered a specific case of the “buy” option (Blaya, J., 2019).

>> 3.1 phases of the life cycle of a technology solution

Ellram's definition, which has served as the starting point for this model, outlines three main phases of the life cycle of a technological solution: acquisition, use, and evaluation and closure. However, the same author acknowledges that this scheme is congruent with the Life Cycle Cost (LCC) methodological approach, but is incomplete if it refers to the TCO method. According to the author, LCC represents a subset of TCO, since the latter has a broader scope and also includes pre-acquisition costs. For this reason, the model proposed in this document includes the preliminary studies phase (Ellram, 1995).

For all the above, four significant phases of the life cycle of a technological solution are contemplated: preliminary studies; acquisition, development and implementation; use and maintenance; and evaluation and closure. Determining to which phase tasks are assigned depends on the project management's own decisions. For example, bidding and awarding tasks can take place in Phase 1 as well as Phase 2. Since the point is to calculate the total cost, it does not really matter to which phase the costs are assigned. In other words, it does not matter where the costs are allocated, the important thing is that they are calculated. [Figure 1](#) shows the different phases and tasks of a digital health project; these will be discussed in more detail in the following subsections.

FIGURE 1 • Phases of a Digital Health Project



Source: Own elaboration.

>> 3.1.1 Phase 1: Preliminary studies

This phase includes all those activities aimed at defining the project and its scope, analyzing its feasibility, and determining the best options for carrying it out. In addition, if the project requires a bidding process, it is also included in this phase, from the identification of the need to the selection of the supplier, which includes, among other actions, the preparation of the terms of reference, the allocation of the budget, the analysis of the offers and the communication of the resolution.³ The study of the internal organization is also part of this phase, both to detect points for improvement and to better adapt the digital solution to that organization. This study is the first step in incorporating the solution into the value chain of the health service, hospital, primary care center or other health centers.

At this stage, the budget is prepared and a decision is made on the strategy for acquiring the solution (buy, build or adapt, among others). In order to make an informed decision that takes into account all costs, a tool should be used to help define and quantify these costs.

Phase 1 Tasks: Preliminary studies



- ☐ Feasibility study.
- ☐ Study of other experiences.
- ☐ Option analysis.
- ☐ Study of the organization.
- ☐ Strategic planning.
- ☐ Preparation of the budget.
- ☐ Bidding and awarding.
- ☐ Process optimization.
- ☐ Change management (training).
- ☐ Change management (communication).
- ☐ Change management (support).
- ☐ Change management (other).
- ☐ Project management.
- ☐ Supervision of contracted companies.
- ☐ Translations.
- ☐ Evaluations.
- ☐ Other.

³ Depending on the country, the terms of reference are referred to as “list of charges” or “technical requirements”, among other names.

Also at this stage, change management tasks are initiated with actions such as the following: communication of the project explaining its importance, information on the project phases, explanation of the expected collaboration and definition of working groups, among others.

These are important change management tasks that should take place in this phase, especially those defined in the first two stages of Kotter's change management model (Kotter, J., 2007; Baum, A., 2019):

- ➔ Establish a sense of urgency: examine the internal and market situation for risks and opportunities, and convince at least 75% of managers that the status quo is worse than the project risks.
- ➔ Form a powerful governing coalition: bring together a committed group with enough power to lead the change effort and encourage them to act as a team even, if necessary, outside the established hierarchy.

In more colloquial terms, this first phase begins when someone in the organization presents the idea of incorporating a digital solution and ends with the signing of the contract with the supplier, or with the first meeting of the project team that must carry out the analysis, development and implementation of the new project.

>> 3.1.2 Phase 2: Acquisition or development and implementation

This phase defines all the activities aimed at acquiring, adapting or developing the solution and putting it into operation. This stage includes, among other tasks, analysis, requirements gathering, development, testing and

proof-of-concept or pilot testing, user training, error correction, production start-up, user support during this period, and any corrections and improvements that may be necessary during implementation. Project managers may prefer to include the bidding and awarding of the project in this stage rather than in the first stage.

Change management tasks in this phase include, but are not limited to, the following:

- ➔ Communication sessions to explain the new project.
- ➔ Creation of working groups for analysis, development follow-up, pre-production testing, pilot testing and mentoring of users during production start-up. Grudin's law on user participation should be taken into account, which states: "When those who benefit from a technology are not those who do the work, then the technology is likely to fail or be subverted" (Grudin, J., 1994. Cited by: Ben-Tzion Karsh, 2010).
- ➔ Relocation of human resources, when necessary, as a consequence of the development and implementation of the new digital health solution.

If it involves the purchase of an external commercial solution, the phase starts the day after signing the contract with the supplier. If it involves in-house development, either starting from scratch, adapting an open source solution or other options, the second phase would begin when the project team starts work.

In any case, this phase ends when the first user of the new solution begins to use it continuously; that is, it is used as a regular tool for the tasks.

Phase 2 Tasks: Acquisition or development and implementation



- ☐ Bidding and awarding (unless carried out in [Phase 1](#)).
- ☐ Acquisition of infrastructure and licenses.
- ☐ Definition and analysis of requirements.
- ☐ Organizational change and improvement.
- ☐ Change management (communication).
- ☐ Change management (support).
- ☐ Change management (other).
- ☐ Functional analysis.
- ☐ Development or adaptations.
- ☐ Proof of concept.
- ☐ Pre-production deployments.
- ☐ Integrated tests.
- ☐ Design.
- ☐ Integrations with proprietary and third-party systems.
- ☐ Data migration.
- ☐ Training.
- ☐ Implementation (production deployment).
- ☐ Support or accompaniment.
- ☐ Adjustments or minor changes.
- ☐ Other.

Phase 3 Tasks: Use and maintenance



- ☐ Project management.
- ☐ Process optimization.
- ☐ Change management (training).
- ☐ Change management (communication).
- ☐ Change management (support).
- ☐ Change management (other).
- ☐ Implementation.
- ☐ Supervision of contracted companies.
- ☐ Architecture and development.
- ☐ Translations.
- ☐ Evaluations.
- ☐ Other.

implementation of the innovation enabled by the digital health solution, so that the efficiency and quality of the processes are improved.

For example, a digital health solution that manages outpatient appointments can improve the process if it allows the patient to manage them online. In addition, this same solution can allow the doctor or nurse, or the support staff of the consultation, to assign a new appointment to the patient when necessary, without the need to go to the admission service of the center. This management of the appointment in the consultation room itself can also refer to those appointments that are the result of medical prescriptions, such as taking samples or radiological examinations. This avoids inconvenience to the patient, and the informed consent documents can be handed over at that moment, when necessary, for the patient to analyze them before the examinations.

Project management does not end when the project goes live. All digital health solutions require management tasks throughout their useful life and even when they are abandoned. For example, monitoring corrective maintenance tasks, accepting or rejecting development proposals and managing any crises that may arise, among others.

>> 3.1.3 Phase 3: Use and maintenance

It includes all the tasks that take place from the first to the last day when the solution is fully operational in a productive environment: i.e. the entire useful life of the solution.

This includes aspects such as maintenance (corrective, preventive and evolutionary), ongoing training, the costs of running the solution and storage, among others. **Process optimization is very important in this phase, which refers to the**

Change management has to be permanent because a digital health solution is constantly evolving, and the modifications adopted will have an impact on the health center's activities. In addition, there is a continuous rotation of personnel in health centers and the incorporation of new professionals, to whom the operation of the digital health solution must be explained, among other tasks. Taking advantage of the benefits for innovation brought about by changes in the digital solution requires change management to be a regular task. **Among others, this task may require actions such as the following:**

- ➔ **Creation of working groups** or assigning new tasks to existing ones, to evaluate the performance of the digital solution, propose improvements, supervise new versions and improvements introduced, as well as the follow-up of new developments, pre-production and pilot tests, and user mentoring during the production start-up.
- ➔ **Communication sessions** to explain to both users and work teams the evolution of the digital health solution and the new functionalities or changes that have been introduced.
- ➔ **Relocation of human resources**, when necessary, as a result of the development and implementation of the modifications to be introduced.

>> 3.1.4 Phase 4: Evaluation and closure

When a system is no longer in use, it is interesting to evaluate both its performance and the costs associated with discontinuing it. On the other hand, a digital solution may continue to generate costs even when it has been completely replaced. Some of these costs may be attributable precisely to its replacement (e.g. data migration), but in this case they would correspond to the start-up phase of the new system and not to the final stage of the solution.

Phase 4 Tasks: Evaluation and closure



- ☐ Change management (training).
- ☐ Change management (communication).
- ☐ Change management (support).
- ☐ Change management (other tasks).
- ☐ Supervision of contracted companies.
- ☐ Maintenance.
- ☐ Translations.
- ☐ Evaluations.
- ☐ Other tasks.

However, there are other costs, often derived from legal requirements for auditing and security, such as maintaining a license in read mode or space on the company's own servers, which are attributable to the old system and should be considered within its TCO. For example, one audit task is to check that records with patient-related information have been deleted, as well as to check that all other data protection measures have been implemented correctly.

In the event that at the end of its useful life it is decided to sell or lease the solution to a third party, income would be generated that must be subtracted from the total cost of the solution. According to the literature review and the information provided by the experts consulted, this rarely happens.

As already indicated, the TCO methodology allows the identification of different cost categories and items. This is an essential task that must be carried out in great detail to avoid the cost of any task remaining unidentified and therefore uncalculated.

>> 3.2 Cost categories and items

Cost categories

- 1) Internal human resources.
- 2) External professional services.
- 3) Infrastructure.
- 4) Licenses.
- 5) Other operating costs.

For the TCO calculation model, five cost categories are considered, which are as follows:

- 1) **Internal human resources:** These correspond to the organization's own personnel. The method proposed for calculating the cost of this category is to consider as cost items each of the professional profiles that will participate in the project and the number of hours that each one dedicates to each task and then multiply them by their cost, which is calculated with the annual salary plus the employer's social contributions. This category does not include the costs of people not linked to the organization's staff, who should be included under the heading of external professional services. [Annex 1](#) lists the professional profiles (cost items) that usually form part of digital health projects.
- 2) **External professional services:** These correspond to the costs (in this case the price at which they are contracted) of tasks performed by professionals outside the organization. This category includes development hours, consulting hours and user training and support sessions, among others, carried out by external professionals or companies.

Also included are the costs derived from the creation of a project management office when this is outsourced. This category also includes the costs of hiring external professionals who are not part of the organization's staff to join the project team.⁴ The cost items in this category are defined by the concept for which each of the services will be contracted. For practical reasons, and for ease of identification, they can be classified by breaking down the professional services expected to be contracted by the tasks of each phase. [Annex 2](#) lists the usual tasks to be contracted in each of them.

- 3) **Infrastructure:** Every technological solution needs a support infrastructure to function. This category includes items such as Internet, storage capacity, network and cabling equipment, computer equipment, furniture and works, among others. [Annex 3](#) lists the usual cost items in this category.
- 4) **Licenses:** This includes all licenses that may be required in a project, such as use of a third-party solution, basic software, software required for the operation of equipment and the cost of software support, among others. This category includes the cost of licenses for a customized solution or the cost of a database manager license. The cost of licenses in the case of SaaS-based solutions is also included herein. Examples of license cost items are shown in [Annex 4](#).
- 5) **Other operating costs:** This includes transportation of people and goods, purchase of campaigns, advertising that does not correspond to change management expenses and other costs that have not been included in the previous categories. Examples of cost items in this category are shown in [Annex 5](#).

⁴ These are external professionals, who bill for their services as a company outside the organization, so they are not included in its payroll.

Table 1 shows examples of the weight of each cost category according to the strategy adopted: buy, build or adapt. As expected, certain cost categories have greater relevance depending on the implementation strategy for digital health solutions. For example, internal human resources concentrate a greater proportion of TCO in strategies that consist of building or adapting an existing solution, while external professional services take on greater relevance in a strategy of purchasing a commercial solution. In turn, the cost related to the acquisition

of licenses is higher in the strategies of purchasing a commercial solution compared to the strategies of in-house development or adaptation of existing solutions, where this cost is usually zero or reduced.

The use of a TCO calculation tool makes it possible to compare different scenarios and implementation strategies and to assess which cost categories and items absorb the largest share of the budget depending on the implementation strategy adopted.

TABLE 1 • Examples of differences in the weight of each category according to the strategy: buy, build or adapt

Phase	Category	Strategies		
		Buy	Build	Adapt
 Preliminary studies	Internal human resources	••	••	••
	External professional services	••	•	•
	Infrastructure	-	-	-
	Licenses	-	-	-
	Other operating costs	••	••	••
 Purchase or development and implementation	Internal human resources	•	•••	•••
	External professional services	•••	•	•
	Infrastructure	••	••	••
	Licenses	•••	-	•
	Other operating costs	•	••	••
 Use and maintenance	Internal human resources	•	•••	•••
	External professional services	•••	•	•
	Infrastructure	••	••	••
	Licenses	•••	-	•
	Other operating costs	•	•	•
 Evaluation and closure	Internal human resources	-	•	•
	External professional services	•	-	-
	Infrastructure	•	•	•
	Licenses	•	-	-
	Other operating costs	-	-	-

Note: - Not applicable. • Low weight of the category. •• Middleweight of the category. ••• High weight of the category.

Source: Prepared by the TCO project team of consultants.

4. Adjustments

The result of the TCO calculation can be affected, as already indicated, by the consideration of indirect costs, inflation rate adjustments and fluctuations in the exchange rate of the national currency. From a theoretical point of view, the TCO calculation should include these three elements. On the other hand, the social discount rate should also be taken into consideration.

>> 4.1 Indirect Costs

In the previous sections direct cost items have been grouped into six different categories. As indicated above, the difference between a direct cost item and an indirect cost item is not the item itself, but the degree of linkage to the final product. Thus, a direct cost is a resource that can be directly linked to the product, whereas an indirect cost has no direct traceability and a criterion must be sought to link it.

One of the main characteristics of indirect costs is their high heterogeneity, which makes it difficult to group them into categories. Indirect costs represent all “structure” expenses, such as office rents, consumption of basic supplies (water or energy), salary costs of administrative and support personnel, and even coffee that may be drunk.

In general terms, the most common difficulty in including indirect costs in the analysis is that they constitute a relatively small portion of total

costs, but calculating how to distribute their weight correctly among the different products of the organization can be a complex task. For example, estimating what proportion of the consumption of water, electricity, Internet, etc., corresponds to each project in the organization can be complicated if it is to be done accurately. Moreover, the decision to include them in the exercise does not necessarily depend on technical criteria related to the calculation method, but rather on the organization’s internal processes (such as its budgeting and resource allocation mechanisms), the type of project or even the public or private nature of the organization.

Thus, for example, for a public hospital that wants to calculate the costs it will incur if it changes its information system, it may not make any practical sense to incorporate as project costs for the implementation of the solution a percentage of the salary of the cleaning, security or catering staff working in the hospital, since these are sunk costs, for which there is no prospect of recovery.⁵ On the other hand, in the same scenario of changing the information system, it is very likely that a private clinic would add in all its calculations an amount to reflect the structure costs.

It is advisable to make an effort to include indirect costs in the TCO calculation of a digital health project, for which a balance between precision and simplicity should be sought. In practical terms, it seems reasonable to add an amount

⁵ Sunk costs are costs that have already been incurred and cannot be recovered in the future. They include time, money or other resources spent on a project, investment or other activity that cannot be recovered.

between 10% and 25% of the total direct costs. In cases where the organization already has an established percentage or where there is background information that allows this percentage to be placed in the context of execution, the established figure should be used, even if it is outside the range suggested herein.

>> 4.2 Inflation adjustments

Digital health solutions usually have a useful life of more than one year. In fact, electronic medical records are “living” organisms, which evolve thanks to their maintenance, so their useful life can exceed ten years. As it is intended to calculate the costs that are generated over the useful life of a solution, they must be valued taking into account the fact that it is foreseeable that money will lose some of its value over time. The temporary inflation adjustment is important in those cases where the organization resorts to external financing to execute the project. A very similar reasoning applies in those cases where professional services are to be contracted from foreign suppliers. Inflation differentials between the national territory and the country where services are being contracted will end up becoming losses (or gains) with a direct impact on the organization’s income statement.

Here again, a balance must be struck between simplicity and accuracy. Predicting the value of inflation rates in the years to come is very difficult, especially in the Latin American and Caribbean region, where rates fluctuate much more than in other regions.

On the other hand, there may be cases where incorporating inflation rate adjustments into the cost calculation at the beginning of the project is an added difficulty that adds little value. This can happen when the project is carried out with the organization’s own resources and staff salary increases are not linked to inflation. Even an organization that only operates in one country may consider that it is not affected by the ups and downs of internal inflation, since it compensates for increases in the supported

turnover with the accrued turnover. It may also be the case that the organizations’ own internal management procedures mean that considering the inflation rate makes little operational sense. This can happen in large organizations, when the total amount of resources available to the department executing the project depends on a budget negotiation that takes place from year to year. It is generally considered that the calculation will be more complete if it takes inflation into account. However, this decision is up to the project or entity management, which should consider its value contribution to the bottom line in relation to the complexity added to the project’s TCO calculation.

>> 4.3 Exchange rate fluctuations

Closely related to the inflation rate are the impacts of fluctuations in the exchange rate of national currencies against the reference currency (usually the U.S. dollar). In the Americas region, a significant proportion of ICT goods and services are invoiced in dollars. In this context, a devaluation of the national currency directly implies an increase in the cost of contracted products, which is passed on to project costs and, consequently, to the organizations’ profit and loss accounts.

Estimating the magnitude of exchange rate fluctuations can be even more complex than inflation. However, it seems clear that it is an element that must be taken into consideration in those projects that include the purchase of ICT goods or services abroad. Exchange rate fluctuations may be the determining factor in deciding, for example, between a foreign and a domestic supplier.

The recommendation is to take into account exchange rate fluctuations as a potential risk of the project. To incorporate them into the final result of the exercise, it is advisable that, once the total amount has been obtained, an estimate be made of how a certain percentage of devaluation may impact the project over the duration of the project.

>> 4.4 Social discount rate

The social discount rate represents the extent to which a present benefit for society is preferable to the same benefit to be obtained in the future. This definition has given rise to two interpretations that form the two main theories of social discounting: that of society's time preference rate and that of the social opportunity cost of capital.

The theory of the social time preference rate conceives the social discount rate as that which summarizes the preferences of society as a whole for present consumption as opposed to future consumption. For its part, the opportunity cost of capital approach considers that the social discount rate should reflect the profitability of the funds required to finance a public project in the best alternative investment (Correa Restrepo, F.J., 2008). Although there is theoretical consensus that the social discount rate should represent the “opportunity cost” of the future (whether of consumers or investors) valued at the present time, it is not easy to translate this idea into a concrete numerical value, which generates or may generate significant distortions (Campos, J., 2016).

The social discount rate has to reflect the rate at which a (large and heterogeneous) group of individuals is willing to sacrifice their benefits and

costs, both present and future (calculated, for example, in terms of wealth or consumption). Thus, in addition to the usual market distortions, aggregate preferences over time must play an important role and the outcome could (and usually does) differ from the private discount rate.

Public sector decisions involve not only deciding which projects to carry out (or when they should be carried out), but also evaluating the various options available. A vast majority of public projects and policies—transportation infrastructure, hospitals, schools, energy policies, etc.—involve large upfront investments, while the benefits are received (at best) only after several months or years, sometimes even decades, have passed. In many projects, for example digital health projects, there are also commitments in terms of repairs and maintenance with effects in the medium and long term (Campos, J., 2012).

The estimation of social discount rates is complex because subjective elements and numerous objective parameters are involved. There is great variability in the social discount rates applied by different international organizations (Mejía, F., 2013). In the event that it is desired to be incorporated in the TCO calculation, the social discount rate calculated for the country where the project takes place or the rate recommended by entities such as the IDB should be applied.

5. Conclusions

All digital health projects in health systems and services must be subjected to cost analysis and opportunity cost analysis, because budgets are finite and priorities must be defined.

- ➔ **TCO is a cost calculation method** that, when applied to the implementation of digital solutions, provides a final figure that reflects not only the acquisition cost, but also those related to the use, maintenance and closure of such solution.
- ➔ **Calculating all the costs that will be incurred** over the useful life of a digital health solution can be difficult because it is easy to overlook key considerations and costs that occur during the life cycle of the project. The IDB has developed a tool to assist in this calculation by identifying the tasks, cost items and their value in each of the four phases of a digital health project: preliminary studies; acquisition, development and implementation; use and maintenance; and evaluation and closure.
- ➔ In each of the four phases mentioned above, the **different cost items** are identified and grouped into five categories: internal human resources; external professional services; infrastructure; licenses and other operating costs.
- ➔ **The TCO calculation follows the following steps:** identify the cost items; assign a value to them and calculate the number of resources to be used.
- ➔ Depending on each organization's criteria, **the calculation results may be adjusted** for the expected inflation rate, currency exchange rate fluctuations and the social discount rate.
- ➔ The final results of the calculation can be taken into consideration for decision-making both on the possible strategies to carry out the project (buy, build or adapt) and for the analysis of its opportunity cost. However, **TCO is neither** an economic evaluation method, nor a project management tool, nor a budget preparation and management tool, nor an analytical accounting or cost accounting system. Nor is TCO a tool that alone can be used to choose between buying, adapting or developing a digital solution.
- ➔ **It should be noted that costs are not the only information to be assessed for decision-making**, but it is important that they are considered for this assessment. Other important factors to consider are functionality, ease of use, local infrastructure, existing systems, availability of engineers or consultants for software maintenance and user support, and the contribution of digital health projects to the local economy, among many other elements.

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Annex 1. Cost items in the category “Human Resources”

- ☐ Project Manager.
- ☐ Functional Analyst.
- ☐ UX Expert.
- ☐ Architect.
- ☐ Programmer Analyst.
- ☐ Developer.
- ☐ Junior Developer.
- ☐ Security Expert.
- ☐ Patient Safety Experts.
- ☐ Database and ICT Infrastructure Administrator.
- ☐ Experts and Users (medical personnel).
- ☐ Experts and Users (nursing personnel).
- ☐ Graphic Designer.
- ☐ Economist.
- ☐ Medical Researcher.
- ☐ Purchasing Department Personnel.
- ☐ Management Personnel.
- ☐ Accountants.
- ☐ Legal Department Personnel.
- ☐ Communication Expert.
- ☐ Translators.
- ☐ Other profiles.

Annex 2. Cost items in the category “External Professional Services”

- ☐ Feasibility study.
- ☐ Study of other experiences.
- ☐ Option analysis.
- ☐ Study of the organization.
- ☐ Strategic planning.
- ☐ Preparation of the budget.
- ☐ Bidding and awarding.
- ☐ Process optimization.
- ☐ Change management (training).
- ☐ Change management (communication).
- ☐ Change management (support).
- ☐ Change management (other).
- ☐ Project management.
- ☐ Supervision of contracted companies.
- ☐ Translations.
- ☐ Evaluations.
- ☐ Other tasks.

Annex 3. Cost items in the category “Cost of infrastructure”

- ☐ Internet (including domain name).
- ☐ Storage.
- ☐ Network equipment and cabling.
- ☐ Physical works.
- ☐ Workplace adaptation works.
- ☐ Acquisition of ICT equipment.
- ☐ Acquisition of medical equipment.
- ☐ Other 1.
- ☐ Other 2.
- ☐ Other 3.
- ☐ Other 4.

Annex 4. Cost items in the category “Licenses”

- ☐ Infrastructure licenses.
- ☐ Basic software licenses.
- ☐ Licenses required for operations.
- ☐ Other 1.
- ☐ Other 2.
- ☐ Other 3.
- ☐ Other 4.

Annex 5. Cost items in the category “Other operating costs”

☐ Transportation of people.

☐ Transportation of materials.

☐ Explanatory documents.

☐ Videos.

☐ Intranet.

☐ Purchase of campaigns.

☐ Dissemination events.

☐ Other 1.

☐ Other 2.

☐ Other 3.

☐ Other 4.

