ICT PSP – Empowering patients and supporting widespread deployment of telemedicine services

MOMENTUM

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Abstract
This report documents five critical success factors related to technology and market relations identified by the Momentum consortium in the implementation and scale-up of telemedicine in European health systems. Each critical success factor is described in depth and analysed in seven telemedicine services from Germany, Israel, Italy, the Netherlands, Norway, Spain and Sweden. The cases represent the different successful implementations of telemedicine in both private and public initiatives and both doctor-to-doctor and doctor-to-patient types of services.

Key Word List

eHealth, Interoperability, Implementation, Market, Procurement, Scale-up, Technology, Telemedicine

Note on the telemedicine cases

The six telemedicine cases described in this deliverable can be located on the MOMENTUM website, called service descriptions, under six countries (Israel, Italy, the Netherlands, Norway, Sweden, and Spain): http://telemedicine-momentum.eu/europe/. A short description of each of the cases (including the Germany Patientenhilfe case) is also included in deliverable D3.2. In this particular deliverable, the critical success factors are not examined in relation to the Patientenhilfe case.

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Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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Executive summary

Momentum's collaborative work has the purpose of elaborating a Blueprint that validates a consolidated set of methods supporting the telemedicine service implementation process. The Blueprint is structured in four dimensions and 18 critical success factors that a telemedicine service has to take into account to implement and deploy the service from pilot to routine care in a successful way. The four dimensions encompass strategy management, organisational management, legal and security issues and technical infrastructure and market relations.

This report contains the analysis of the technical infrastructure and market relations identified for mainstreaming telemedicine deployment in daily practice by means of five critical success factors:

- Ensure that the appropriate information technology and eHealth infrastructure are available.
- Ensure that the technology is user-friendly.
- Put in place the technology and processes needed to monitor the service.
- Maintain good procurement processes.
- Guarantee that technology has the potential for scale-up.

Throughout the revision of different telemedicine services from a small number of countries in or near Europe (Israel, Italy, the Netherlands, Norway, Spain and Sweden) that made the leap from pilot to routine care, each critical success factor has been defined and documented. The cases represent several configurations in terms of ownership (public and private) and types of end-user (health professionals and patients) which makes them applicable to multiple other telemedicine scenarios.

All five critical success factors were present in the cases reviewed although slight differences were found between public and private promoted cases due to their different missions: either to reach wider market bases or to deploy telemedicine at large scale in an organisation or health system.

1. Introduction

Telemedicine services are the practice of medicine at a distance. While there were some early telemedicine experiences using first generation telecommunication systems such as the radio or the telephone, the expansion of modern information and communication technologies has brought a wave of innovation in the telemedicine field.

Implementing telemedicine services is a multi-faceted challenge. Telemedicine doers have faced such challenges as cultural resistance from patients and health professionals, technological difficulties and organisational upheavals during telemedicine implementation. As a result, many telemedicine initiatives hardly manage to proceed further than a pilot phase.

Modern healthcare requires introducing new ways of producing and delivering cure from diseases and caring. They can help to deal with current societal challenges such as healthy ageing, equitable access and the burden of chronic diseases. Telemedicine is a long-term sustainable type of service that still needs initial investment and continuous support until it overcomes the tipping point of its learning curve.

This report focuses on five current success factors identified in the technological and market relations domain that have been observed in six telemedicine services deployed in different European regions or nations.

Experiences from Israel, Italy, the Netherlands, Norway, Spain and Sweden serve as the basis to describe and analyse the contribution of the following five critical success factors to telemedicine service deployment: information technology (IT) infrastructure and eHealth infrastructure; user-friendliness; service monitoring and maintenance; good vendor relations; and the service's potential for scale-up.

2. Ensure that the appropriate information technology infrastructure and eHealth infrastructure are available

This section of the report describes the issues surrounding ensuring that the appropriate IT and eHealth infrastructures are available at the time of deployment and scale-up.

2.1 What this critical success factor is

This critical success factor means ensuring that the appropriate IT infrastructures and eHealth infrastructures are available so that the telemedicine implementation can rely on these infrastructures from the initial deployment to the last stage of the scale-up phase.

The distinction between IT infrastructure, eHealth infrastructure and eHealth services such as telemedicine is represented in the working model developed by the CALLIOPE project in 2011 (see the figure below).[1]

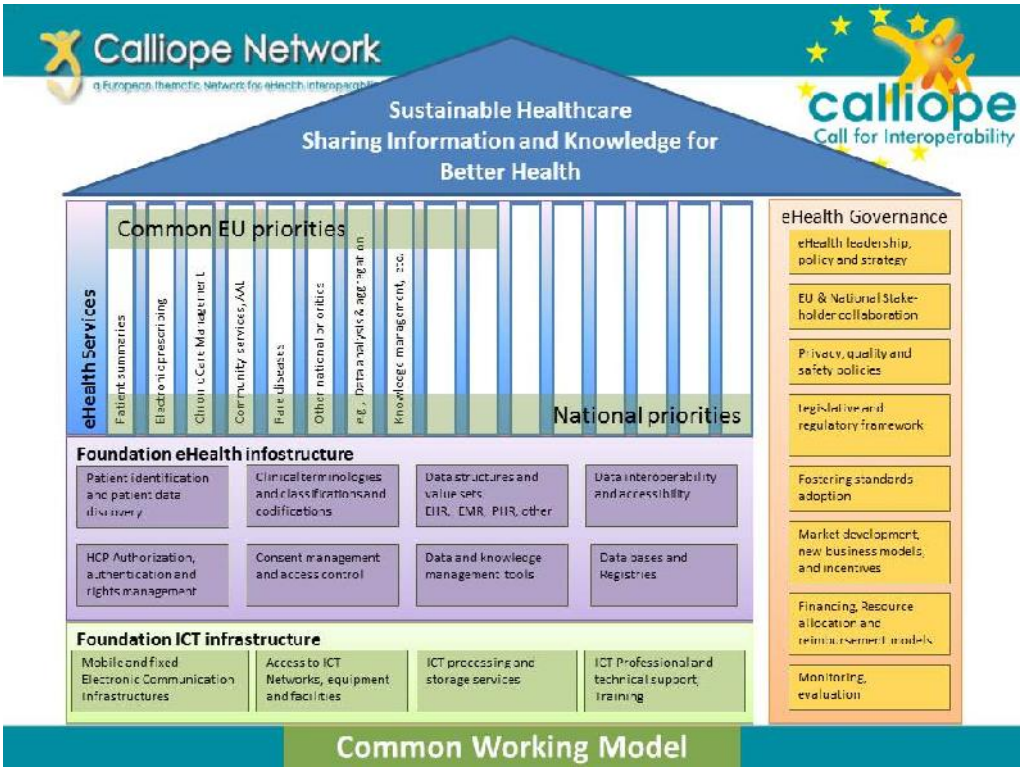

Figure 1. Calliope Common Working Model

IT infrastructure consists of all the active elements in IT operations. A typical IT infrastructure includes the following elements: hardware, software, networks (including internet connection and security systems) and the IT staff responsible for network, hardware

[1] Available at: http://www.calliope-network.eu. To the three layers of the project, the Momentum project has advanced the pillar entitled "eHealth Governance", which is related to the critical success factors addressed by the two Momentum deliverables, D4.2 "Strategy and Management" and D6.2 on "Legal, regulatory and security issues".

and software development and maintenance. All together have the mission to supply access, storage and processing capacity to the service users.

In the context of telemedicine, IT infrastructure is the set of industry-neutral infrastructure elements (available for all sectors) that supports the successful deployment and good functioning of new healthcare services.

eHealth infrastructure is a sector-specific subset of the IT infrastructure. It includes hardware, software or networks designed specifically for healthcare provision. For instance, health information systems incorporate elements such as electronic health records or patient health records able to capture, store and distribute clinical data across different levels of care and among different health providers and patients.

The communication of health data may require interoperable health information systems that follow clinical terminologies, codifications and data exchange standards such as DICOM, HL7 or SNOMED.[2]

2.2 Objectives

The main objectives of this critical success factor are related to the efficiency and the interoperability of the telemedicine service.

First, ensuring that these infrastructures are available is crucial to reduce development and implementation costs of telemedicine services by relying on and using existing IT and eHealth infrastructures without risking the quality of the new service or its obsolescence over time.

Second, using available IT and eHealth infrastructures means that the new telemedicine service is embedded in current information systems. It guarantees the service's interoperability with other healthcare services or healthcare providers. Stand-alone solutions run the risk of being refused by end-users.

2.3 The context surrounding the success factor

The need for eHealth infrastructure criticality varies depending on the type of telemedicine service initiative. In the case of private vendor initiatives that aim to sell telemedicine services in a healthcare market, the design of interoperable solutions to their potential customers is fundamental. In the case of public or private provider initiatives, the critical point is the scale of the implementation plan measured by the number of organisations or centres that will be involved and the diversity of health information systems that they operate.

Complex eHealth infrastructure contexts (for example, when there are at least two health information systems operating together, even within the same healthcare organisation) require health data integration i.e., interoperability.

[2] See section 8 of this deliverable for a glossary of terms.

Another contextual factor is the type of telemedicine service involved. In doctor-to-patient initiatives, the availability of appropriate IT infrastructure is of more influence in the implementation than the eHealth infrastructure. The latter has a larger influence in doctor-to-doctor initiatives because health professionals expect health information systems integration to better support the care on offer.[3]

In the telemedicine field, access to electronic health records and clinical data provided by other health providers may be needed in order to share data and avoid data silos. Here, the health system configuration will be important, as better data integration in health systems with a strong IT stewardship will be expected.

2.4 First thoughts on pre-requisites underlying the success factor

Public or private telecommunication operators will have had to invest in a network IT infrastructure (i.e., broadband) that is mature at the time of implementation.

The health information system that will capture telemedicine data must be ready to accept data from third-party sources through intercommunication systems (such as web services) or evolve in parallel with the telemedicine implementation to accommodate these data interoperability needs.

2.5 Illustration of this critical success factor from the Maccabi case

The Maccabi chronic disease management service is based firmly on a number of technological features that help to show that the initiative is a modern healthcare case.

The Maccabi example encompasses the use of an electronic healthcare record system that is used with other Maccabi applications, a computerised central medical record, a computerised call centre management and patient management infrastructure, computerised clinical protocols embedded in the electronic healthcare record and a videoconferencing and telemonitoring system to communicate with patients who are at home. Together, all these technological elements act as a global telemedicine service for delivering high quality care to patients with chronic conditions.

The interoperability of the infrastructure is critical for the Maccabi institution and its healthcare professionals so as to facilitate transitions of care and integrate the full cycle of care whether the care is provided face-to-face or virtually.

2.6 Illustration of this critical success factor from the RxEye case

Because RxEye is a Swedish eHealth solution designed to provide radiological knowledge and advice from the distance, the system was built to serve different clients. It consists of a web platform for transmission and radiology image reading and reporting. It relies on the available broadband infrastructure and uses standard data communication systems over the net (both HTTP and FTP).

[3] Here, the notion of a doctor includes all kind of other health professionals.

The quality of the teleradiology reporting service depends on the availability of digitalised referral letter, clinical data, previous imaging reports and images, current examinations, and other reports. Existing eHealth infrastructure is mandatory for achieving a similar quality of service with teleradiology as with on-site radiology.

In terms of interoperability, the nature of this radiology-related service required it to be connected with customers' PACS and radiology information systems.

2.7 Illustration of this critical success factor from the Teledialysis case

The Norwegian teledialysis service is a telemedicine service based on synchronous video and audio two-way communication. It required a pre-established broadband network to allow real-time communication. The Norwegian broadband network was mature at the time of the teledialysis service implementation and this thus helped the service to be rolled out without problems.

The videoconference solution adopted by the teledialysis service was off-the-shelf equipment (Cisco TelePresence System Edge 95)[4] which brought reliability and reduced implementation risks that could otherwise have been faced with newer IT developments.

Interoperability was involved when accessing the electronic health record available during doctor-to-patient consultation and in recording documentation of the treatment. Initially, the staff in the local units and in the university hospital documented the patient treatment in the same electronic healthcare record. Then, the local units installed new dialysis machines with a documentation system incompatible with the electronic healthcare record system at the university hospital. Therefore, they stopped documenting patient treatments in the same system.

There also turned out to be some legal hindrances since the (then) newly passed Norwegian Health Register Law prohibited employees in one health institution from documenting patient treatment in another health institution's electronic healthcare record.

2.8 Illustration of this critical success factor from the ITHACA case

ITHACA was conceived as a consortium venture in which three different organisations brought together their capacities to build a new telemedicine service for patients with blood pressure disorders.

Indra[5] was the venture partner responsible for IT development. It is a Spanish IT and defence systems company with broad experience in developing complex IT solutions for a range of different industries including healthcare.

The solution developed by Indra had to be integrated with Badalona Serveis Assistencials (BSA) health information systems. The interoperability of this connection became mission-

[4] Fact sheet: http://www.cisco.com/c/en/us/products/collateral/collaboration-endpoints/telepresence-system-edge-mxp-series/data_sheet_c78-628575.html

[5] More information about Indra is available at: http://www.indracompany.com/en/sobre-indra/compania-global-de-ti

critical in so far as it needed to avoid duplications in computerised physician order entry (i.e., there should not be two health records) and reduce clinical workload. Ultimately, ITHACA's solution was successfully integrated with the BSA current electronic health record in one direction, extracting data from BSA's electronic healthcare record so as to display it in ITHACA systems. ITHACA is fed by BSA electronic healthcare record data so that clinicians do not have to feed data manually into the ITHACA system.

ITHACA is a solution based on telecommunications standards for data exchange (such as WWW and SMS) and voice communication (GPRS).

2.9 Illustration of this critical success factor from the KSYOS case

To ensure deployment of KSYOS's own system, both IT and eHealth infrastructures were critical to deliver its telemedicine services. KSYOS understands criticality as the appropriate combination of a reliable IT infrastructure and the capacity to interoperate with customer's information systems to reduce workloads and increase quality and customer satisfaction.

KSYOS considered IT infrastructure in its second phase of development when usability research was performed and in its fourth phase when the company scaled up its solutions.

2.10 Illustration of this critical success factor from the Cardio Online Europe case

The telecardiology system of Cardio Online Europe definitely pays particular attention to IT infrastructure as it depends on it to deliver timely urgent care.

The service has the most recent hardware technology (Cardiovox P12 and Cardiolink)[6], while the software used for the heartline receiving system works on an Oracle database. In 2013, Oracle developed a new hardware product with all the best features for the scope of this task. This Oracle database application, on a scale of values, ranks in one of the top places in terms of performance.

Cardio Online Europe has three levels of networks that are synchronised with its database. Electricity and telephone dashboards are tested daily by technical staff. The service also has another room in the same office for a central telecardiology backup system.

The output file of the electro-cardiogram (ECG) report can be downloaded in real time from the internet as a jpeg or pdf file. The heartline receiving system data files and database are interoperable with the health information systems.

Because IT infrastructure must always be functional, in Cardio Online Europe's case, this critical success factor can be seen to be closely associated with another critical success factor: that of service monitoring.

[6] More information about Cardio Online Europe technology is available at: http://www.cardioonlineeurope.com/pagina.php?azienda=1

2.11 Lessons learned on information technology infrastructure and eHealth infrastructure from the cases

Appropriate IT infrastructure was found to be relevant in the implementation of all the cases reported on. The maturity of communication systems developed in the last decade has, without doubt, contributed to easing development and acceptance of telemedicine services. The use of technology standards is a guarantee of success and efficiency, as has been spotted in various cases: videoconference in Teledialysis, web development standards in Maccabi, ITHACA and KSYOS, and communication standards in all six cases.

Interoperability supported by appropriate eHealth infrastructure has differed among the cases. On the one hand, in those cases which are private initiatives and are oriented to the market (such as KSYOS, RxEye and Cardio Online Europe), to deploy integration with customer health information systems was critical to success. On the other hand, eHealth infrastructure has been proven fundamental to enable de facto scaling-up in the Maccabi case and the potential to scale up in ITHACA and Teledialysis.

Moreover, eHealth infrastructure has brought quality of care and efficiency to these telemedicine services. In the Maccabi case, system integration was a guarantee of high quality care, while in all cases it helped to avoid duplications and errors in data entry.

2.12 Overall analysis on information technology infrastructure and eHealth infrastructure from the cases

The appropriateness and availability of information technology infrastructure and eHealth infrastructures was illustrated by all cases. At the present time, technology has reached the maturity level to allow the application of telemedicine solutions in a safe and reliable way for all types of users. However, a difference in the scaling-up approach was detected between cases based on the nature of their configuration. Private and market-oriented cases (such as RxEye, KSYOS and Cardio Online Europe) followed closely technology standards, and they were keen on adopting interoperability standards to maximise their market opportunities. On the other hand, public sector-promoted cases (Maccabi, Teledialysis and ITHACA) relied on interoperability standards to improve their scaling capacity.

2.13 Further relevant discussion

Often, IT or eHealth infrastructures are not in place. Health and clinical information systems are often only partially deployed. Interoperating with them can be difficult in addition to being very costly. Paradoxically, the smaller the size of the telemedicine initiative, the greater the resulting budget burden of IT infrastructure is due to economies of scale.

The time dimension of technology solutions' availability is as important as the space dimension. Some telemedicine solutions are so advanced that they encounter adoption difficulties due to a lack of technological skills or technological awareness on the part of institutions and health professionals or even patients. It is therefore important to ensure that technology is in the right place at the right time.

3. Ensure that the technology is user-friendly

This section of the report describes the issues surrounding ensuring that the technology used in the telemedicine deployment is user-friendly.

3.1 What this critical success factor is

This critical success factor means making sure that the technology used in the telemedicine deployment is user-friendly. The technology referred to here relates not only to end-user devices and displays but the whole system configuration.

User-friendliness is a combination of attributes from both technical and human dimensions that helps the user to learn and adapt easily to a new technological environment (Lehoux 2004). These attributes include simplicity, responsive design, and usability. Users adopt innovation easily when they perceive it as simple and easy-to-use. Responsive design is a method to achieve simplicity and usability through user-centred design. User-centred design is mainly achieved through user involvement in the design process. Simplicity and usability in technology is also related to the use of standards that reduce unnecessary technological dependencies.

From a technological perspective, all these features together should bring fitness for purpose, cost efficiency, ease of understanding and use, and reliability to all telemedicine service users. Thus, user-friendliness in a telemedicine service is critical to increase the speed of user adoption and avoid rejection by end-users.

3.2 Objectives

User-friendliness has two objectives. On the one side, it aims to make the technology easy to use by an average user (whether the user is a health professional or a patient) without the need for a long learning curve or an extended training period or process. On the other side, the technology has to be reliable both at device and system level.

3.3 The context surrounding the success factor

The technological and organisational context where the new solution is set up determines the level of environmental complexity. For example, the co-existence of multiple health information systems or having a heterogeneous user base (i.e., involving a mix of different types of users with a range of different skills) may require an additional effort being made towards user-friendly design.

This will help to avoid users experiencing feelings of complexity, particularly when health professionals have to work with different information systems.

When the telemedicine service end-users are the patients, the human dimension of user-friendliness is even more important for the system to be accepted by a diverse user base.

3.4 First thoughts on pre-requisites underlying the success factor

Two pre-requisites are important when developing user-friendly technology: they are simplicity and eHealth literacy.

Simplicity is a subjective experiential factor that is measured by end-users. It may determine the degree and speed of adoption.

The level of eHealth literacy (that is, e-skills applied to healthcare) (Chan et al 2009) of both health providers and patients will ultimately be a pre-requisite for the success of this critical success factor. Earlier exposure to IT-based healthcare helps end-users to adopt new telemedicine services more easily. Moreover, the work done in change management plans can improve the point of departure in terms of eHealth capacities.

3.5 Illustration of this critical success factor from the Maccabi case

User-friendliness is a critical success factor in the Maccabi service as the target patient population is not necessary tech-savvy. For instance, the tablets used for video conferencing between patient and nurse have only one use. Hence, the patients have only to touch one button to connect with their nurse. Those patients who do not have tablets contact their nurses by telephone.

3.6 Illustration of this critical success factor from the RxEye case

RxEye service depends critically on the fact that the teleradiology service should not change routines in the radiology department which is outsourcing reporting. RxEye service does not require major changes in local software or hardware setup. The technical platform is common for all functions and products. The teleradiology buyer should make a single infrastructure installation and integration with its own information system.

3.7 Illustration of this critical success factor from the Teledialysis case

The technology deployed in Teledialysis is not very complicated and it was user-friendly from the outset through its own design. The system is flexible in the way that not all the possibilities are used at all times, but are adapted to the actual needs of the end-users.

3.8 Illustration of this critical success factor from the ITHACA case

Inspired by its patient-centred framework, ITHACA is a user-friendly solution. Its user-friendliness has been validated by the different satisfaction surveys performed with regard to the service. Patients may access ITHACA services in different ways, including via letters, telephone, or interactive web-based services.

3.9 Illustration of this critical success factor from the KSYOS case

User-friendliness and safety were two aspects particularly encompassed in the second phase of KSYOS's development: when it undertook internal and external testing and usability research. The goal was to assure end-users, both general practitioners and hospital

specialists, that they would feel comfortable using KSYOS interfaces and ensure that they would engage immediately with its functionalities.

Any potential steepness in the adoption learning curve was reduced through an enhanced user-friendly design.

3.10 Illustration of this critical success factor from the Cardio Online Europe case

The electrocardiographs used in the Cardio Online Europe case (which are Aerotel medical system Cardiovox P12) are extremely easy to use and have a user-friendly design.

By pressing only one button, the doctor records and, in a few minutes, sends a 12 leads standard electrocardiogram. The transmission involves acoustic coupling. The sound produced can be transmitted by every telephone system, from the ambulance's telephone, from the doctor's phone, from the patient's home, or from any device capable of making a phone call.

Cardio Online Europe is aware that other communication systems exist. But the company also knows that every signal transmitted by the internet or any other digital system must be electronically transmitted from start to end. If not, the trace cannot be recognised. For this reason, the company has opted for an analogue solution, because the sound produced by Cardiovox P12 can be transmitted in every transmission mode.

3.11 Lessons learned from the cases

Maccabi and ITHACA have patients involved as telemedicine service end-users. Their solutions offered a wider range of accessibility to cover the diversity of chronic care patients and stressed the importance of simplicity in user interfaces to compensate the risk of complexity of a multi-channel approach.

The rest of the cases reviewed (RxEye, Teledialysis, KSYOS and Cardio Online Europe) were doctor-to-doctor types of telemedicine service where healthcare quality and safety, and user comfort, were crucial so as to be accepted as an alternative care service by the health professionals involved.

In conclusion, user-friendliness is mission critical in accelerating user adoption of telemedicine services and reducing the risk of rejection due to a lack of usability.

3.12 Overall analysis on user-friendly technology from the cases

User-friendliness was fundamental in the design and implementation phase in all the cases reported on to guarantee and support an easier user adoption. A different approach to usability was clearly identified among those cases which depend on their orientation on end-users. The cases typified as doctor-to-doctor telemedicine services focused on usability to avoid additional data-entry and reduce clinicians' workload while doctor-to-patient cases (such as Maccabi and ITHACA) focused on usability in terms of accessibility to patients.

3.13 Further relevant discussion

User-friendliness benefits when end-users are involved in the design process. As the Christie Commission of the Scottish Government on the future delivery of public services proposed, effectiveness can be further increased through bottom-up design approaches and particularly throughout the involvement of people and communities. Usability should be included in the design and deployment processes (Christie 2011).

4. Put in place the technology and processes needed to monitor the service

This section of the report describes the issues surrounding putting in the place the technology and processes to monitor the service.

4.1 What this critical success factor is

Service monitoring is the function of guaranteeing that the telemedicine service is up and running without any form of excessive delay in routine use or technical interruption – except for those interruptions scheduled for system maintenance. Service monitoring includes all activities to govern IT such as maintenance plans, security issues, service continuity, help desk, access management.

The introduction of technology in healthcare practice has to avoid at all costs time losses on the part of the clinicians, as this is a big source of frustration to them as it may prevent them from caring for patients. Therefore a good quality technology services monitoring service is important so as to guarantee continuity of care.

Service monitoring may be provided either internally by the healthcare service provider or externally through a contractor.

It is also important to consider the needs of end-users in order to identify possible refinements that improve adoption and use of the service. Staff members involved in service monitoring are in a privileged situation in terms of capturing end-users' needs as their main activity is trouble-shooting.

4.2 Objectives

A successful telemedicine service monitoring implementation has the following objectives. Service monitoring is intended to:

- Guarantee a continuous level of service.
- Solve any incident that may occur during the service.
- Support end-users in resolving any doubts that they might experience.

Besides these three objectives, it is also important to understand the context surrounding this critical success factor.

4.3 The context surrounding the success factor

The level of structuring of the service monitoring will probably depend on the type of service contracted or developed, and how long the service has been running. It will also be important to define who is providing this service in the case of a joint venture: it may be the same company that develops the service or it may be a third party that is responsible for maintenance and service contracts.

Other contextual factors are the type of synchronicity (online as compared to offline services) and the scale of the telemedicine service in terms of its size and the number of

organisations involved. The larger the scale or the customer base, the more critical this success factor becomes.

4.4 First thoughts on pre-requisites underlying the success factor

As an after-sale type of services, service monitoring may or may not be included in the contracted or developed service. The telemedicine doer needs to verify the specificity of any service level agreements in the signed final contract to avoid any lack of compliance with any of the objectives described for service monitoring.

4.5 Illustration of this critical success factor from the Maccabi case

In the Maccabi case, that of a large healthcare organisation chronic disease management service, IT service monitoring is critical to the long-term sustainability of the service. As a large-scale implementation within this healthcare organisation, IT monitoring is mostly done by Maccabi's IT department. External providers, like the company that is providing the tablets (Avaya) as well as a telephone company, support Maccabi's maintenance team.

4.6 Illustration of this critical success factor from the RxEye case

Service monitoring has a double role in the case of RxEye. The nature of this service, which involves the outsourcing of radiology diagnosis, requires a joint effort from an IT perspective. On the one side, RxEye needs to be available to receive radiological images and send diagnostic reports to its healthcare clients. On the other side, the client IT system has to be able to store and send radiological images and receive, store and integrate radiology diagnostics into its health IT infrastructure. Therefore, a good collaboration with the customer's IT governance team(s) is important to deliver a good service level.

4.7 Illustration of this critical success factor from the Teledialysis case

The IT system involved in Norwegian teledialysis is based on three main technological elements:

- A videoconferencing system over internet protocol.
- Medical equipment capable of being used with the assistance of a local nurse or physician assistant (e.g., ultrasound, an electronic stethoscope and a dialysis machine).
- A health information system to store and access patient data (in the electronic health record).

Therefore, service monitoring has to ensure the maintenance of all three types of technologies (video conferencing; medical equipment; and a health information system) which involve a diverse maintenance team. In this case, it is the same organisation which monitors and supports all the IT systems at the hospital.

4.8 Illustration of this critical success factor from the ITHACA case

Services maintenance and monitoring was outsourced to Indra, the technological partner in the ITHACA venture. Indra is used to large technological projects in different sectors. In the

case of ITHACA, it has provided excellent service maintenance to date and has developed new features of the web platform as required by BSA.

4.9 Illustration of this critical success factor from the KSYOS case

KSYOS paid attention to the quality of service monitoring in its fourth phase of activity during which its services were scaled up to routine care in a large customer base. For KSYOS, scale was a determinant of the back-office infrastructure that is required to guarantee uninterrupted service. KSYOS executives adopted a proactive approach to maintenance, actively monitoring the service performance to improve user experience.

4.10 Illustration of this critical success factor from the Cardio Online Europe case

Telecardiology services offered by Cardio Online Europe in Puglia region are supported by an IT infrastructure that needs to be fully functional on a 24/7 basis to receive, read and transmit electrocardiograms. Due to the medical criticality of this support, service monitoring is crucial. More than a third of the electrocardiograms sent are received during night shifts, and 12% of patients have reported serious diseases.

Cardio Online Europe has a dedicated section in its customer satisfaction survey to check the customers' satisfaction with service monitoring. The section contains questions considering the needs of users that range from issues around instructions for use to technical assistance. Cardio Online guarantees the replacement of devices within 24 hours from any call requesting support. Devices are tested frequently. Every five years, the equipment is collected and sent to check-up centres, which is what the law stipulates.

4.11 Lessons learned on putting the technology and processes in place needed to monitor the service from the cases

Two out of the six cases reviewed had internal service monitoring (Maccabi and Teledialysis). In the case of Maccabi, the quality assurance of a big scale-up in a large healthcare organisation motivated the decision whereas, in Teledialysis, it was supported by the diverse maintenance requirements of the telemedicine service. In the other four cases (RxEye, ITHACA, KSYOS and Cardio Online Europe), service monitoring was provided by external suppliers in the case of ITHACA, and by their own telemedicine companies in the remaining cases. It is not unexpected that service monitoring is part of the value proposition of telemedicine vendors.

What can be learned from these cases is the importance of a good form of collaboration organised with customers' IT governance teams in order to guarantee a high level of service and integration.

Two other significant lessons are the importance that service monitoring has to do with the scale of the telemedicine service (Maccabi), and the criticality of the healthcare service provided (Cardio Online Europe).

4.12 Overall analysis on the technology needed to monitor the service from the cases

The technology and processes required to provide a continuous and reliable maintenance and telemedicine service monitoring was present in all cases. Vendor initiatives had service monitoring as a key value proposition. Healthcare providers opted to internalise the service with the exception of ITHACA. In ITHACA's case, this option was not selected due to its partnership with an IT company. In all cases though, a good collaboration among service monitoring teams and technology providers was seen as crucial to guarantee the quality of the service.

4.13 Further relevant discussion

Service monitoring needs to be tackled from a dynamic perspective. It has a present aspect and a future aspect. It is not enough simply to guarantee a well-functioning system at the present time. It is also necessary to explore how maintenance will adapt to future changes in the technological and administrative environments, and how these changes will be supported financially. Often, it is the service monitoring team that is in charge of further developments of the technological – mainly software – infrastructure to support the telemedicine service.

5. Maintain good procurement processes

This section of the report describes the issues surrounding ensuring good procurement processes.

5.1 What this critical success factor is

Good procurement processes involve two main focus areas: content and method.

As for content, any service that is contracted may be delivered with a wide range of quality variability. Unless these aspects are specified in the contract signed with telemedicine providers, the risk is fully transferred to the procurer. A good practice in good procurement is to specify these aspects in a transparent, straightforward service level agreement to be signed by contracting parties.

By method, we refer to the formal process of procurement as a guarantee of the quality of the final output, the purchase. This encompasses issues of transparency and competition present in procurement legislation derived from a European directive on public procurement (Directive 2014/24/EU).

5.2 Objectives

Good procurement processes aim to ensure the fairness of the relationship between the procurer and the provider, the quality of the service during the terms of the contract and, in the case of public procurement, to guarantee the competition of different providers.

Quality is ensured by the underwriting of service level agreements and contracts that clearly define what it is expected from both parties and what are the specific rights and liabilities of engaging in the particular telemedicine project or initiative.

5.3 The context surrounding the success factor

Healthcare organisations have to be accountable for their operations to different stakeholders. In the case of public institutions, this is legally reinforced by the obligation to be compliant with the relevant public sector public procurement laws derived from a European Union directive. This type of legislation regulates how the procurement process has to be undertaken in terms of competition, publicity and duration.

Private organisations enjoy a higher degree of freedom in their procurement methods but remain accountable to their boards of trustees and may regulate internal procedures with warranties similar to those practiced in the public sector. Public-private initiatives introduce an additional complexity into the procurement process as the solution to be found has a pre-commercial character.

Procuring telemedicine services has a particular feature related to contracting services based on data. Data protection and privacy issues are at stake and have to be formally addressed in the contract clauses.

5.4 First thoughts on pre-requisites underlying the success factor

A facilitating characteristic in the contracting process is the availability of guidelines and service level agreement templates used in previously contracted services that may guide new procurers of services to avoid any past errors.

In classical procurement, the market needs to be large and competitive enough to be able to deliver the required technology whereas, in pre-commercial procurement, the market needs to be ready to step in and hence to have enough of a business perspective (Bos 2008).

5.5 Illustration of this critical success factor from the Maccabi case

Maccabi's procurement department experience enabled it to procure the array of services needed by means of a set of clear contracts that defined the appropriate deliverables, schedules, maintenance and responsibilities. Clarity in the procurement process (what is expected and what will be provided) was considered to be critical to the success of the implementation of the service.

5.6 Illustration of this critical success factor from the RxEye case

RxEye dealt with the contracting process as a provider rather than as a client. As a telemedicine service provider, RxEye has relied on flexible and secure online contracts to guarantee the level of service provided and data protection. RxEye is providing customers with the software to send and receive referral letters, images and reports, to buy and sell medical image reporting, and to make contracts between parties. In this regard, RxEye is a vendor: according to its service level agreement and other contractual conditions, it should definitely provide support, maintenance and development of the system.

5.7 Illustration of this critical success factor from the Teledialysis case

The managers of Teledialysis had access to experts on video conference equipment in order to define the necessary requirements for the "package" (a configuration of solutions and procurement knowledge). They also had access to the general procurement expertise at the hospital.

5.8 Illustration of this critical success factor from the ITHACA case

Good vendor relations were secured through contracts and agreements among the three partners in the telemedicine initiative, BSA, Indra and Novartis. The impetus to formalise agreements came from all partners as potential for scalability was foreseen from each party. For instance, Novartis envisioned to extend the ITHACA system to other pathologies related to its therapeutic lines (in the fields of cardiovascular, respiratory or endocrinology). Indra was comfortable acting as a technological provider for ITHACA as well as to be able to export the solution to new customers.

In terms of counselling, BSA obtained legal advice from its procurement department which it used to draft and issue service contracts to support healthcare delivery. Novartis and Indra were also assisted by their own legal departments.

5.9 Illustration of this critical success factor from the KSYOS case

In the case of KSYOS, the character of this critical success factor needs to be understood in the same way as in the case of RxEye.

KSYOS acts as the vendor rather than the client. The company developed a telemedicine technical solution that is marketed jointly with medical diagnostic and consultation services. So, good procurement practices were scoped during KSYOS's fourth phase of development. In this phase, it scaled up its services and offered them to various medical groups through a set of different contracts and agreements that covered both the near-term and long-term.

5.10 Illustration of this critical success factor from the Cardio Online Europe case

Cardio Online Europe regards good practice with vendors from a similar position as that of KSYOS and RxEye. All are providers of a telemedicine solution, so they handle this critical success factor differently from several of the other cases.

Cardio Online Europe delivers services to the public health care system in the Italian province of Puglia as well as to private hospitals with which it has signed collaboration contracts. Therefore, the Puglia region acts as the procurer. In these contracts, service level agreements are laid out that Cardio Online Europe has to fulfil.

5.11 Lessons learned on maintaining good procurement practices from the cases

Particularly when care teams are experiencing telemedicine for the first time, any uncertainty involved in the telemedicine services can act as a recommendation for reducing ambiguity through the signature of clear service level agreements. In the procurement process, specifying with clarity the various functions and deliverables of the service is a cornerstone both for clients and providers of telemedicine services. In order to streamline this process, having access to expertise in their procurement departments appeared to be indispensable to the Teledialysis and ITHACA projects.

This factor emerged as primary in the case of ITHACA, where a public-private partnership was formed to develop the telemedicine service. Clarity in the procurement process, and having an agreed business plan, may help to define the levels of responsibility, ownership and further developments, thus uncovering the venture partner's agendas.

As providers of telemedicine services to healthcare organisations (which was the case in terms of RxEye, KSYOS and Cardio Online Europe), having good procurement processes proved to be relevant as most of their potential customers have to follow public procurement legislation.

Despite the fact that none of the cases explored reported on following a pre-commercial procurement process, one may consider that public initiative cases (like Maccabi, Teledialysis or ITHACA) were in fact pre-commercial developments: for example, all the risk

was borne by the healthcare provider in Maccabi and Teledialysis, and was partially distributed in the case of ITHACA.

5.12 Overall analysis on maintaining good procurement processes from the cases

Clarity in the procurement process and access to expert advice was considered in all cases to be critical in order to face better future developments of the telemedicine services. A lack of guidelines in pre-commercial procurement was detected particularly in healthcare providers' initiatives (such as Maccabi and ITHACA).

5.13 Further relevant discussion

Procuring telemedicine services is not an easy task. A high degree of uncertainty is present both in the design, development and deployment phases.

Innovative procurement methods have been developed in recent years. Systems like innovative public procurement or pre-commercial procurement are now being tested to develop services that involve the interface of healthcare and technology. Particularly, pre-commercial procurement helps commissioners of services to reduce their level of uncertainty and transfer part of the risks involved to competitive providers. As a result, the procurement process has become more flexible (Edler & Georghiou 2007).

Telemedicine development and implementation is not a linear process. Uncertainty increases with the presence of multiple partners. In order to avoid confusion among the partners involved in such an eHealth journey, a clear definition of roles and responsibilities as well as a determination of timelines and milestones has to be specified in the various binding documents associated with procurement processes.

6. Guarantee technology has the potential for scale-up

This section of the report describes the issues surrounding aiming to guarantee that the technology used has the potential to be scaled up.

6.1 What this critical success factor is

This critical success factor means considering that, from a technological standpoint, it may be important to grow and extend the telemedicine service developed to a larger scale.

Therefore, the appropriate vendor and the right technology need to be chosen. The potential for scale-up can be achieved by using either standard technologies or technologies that are similar and yet are produced/offered by a range of suppliers. Failing to do this may work in the short term and on a small scale, but will probably cause bottlenecks at the scaling-up stage.

6.2 Objectives

The telemedicine doer has to take into account what actions are needed to make the leap from pilot to large-scale deployment in both technological and commercial terms.

Scalability is directly related to the degree of standardisation of the technical solution as defined by market adoption (*de facto*) or specified by a standardisation organisation (*de jure*).

6.3 The context surrounding the success factor

When the telemedicine solution depends on a technology partner or provider, scalability may be a condition of provider lock-in. Both the existence of a competitive market to avoid supplier-dependency and the specifications in the contracts provide ways to be able to scale up.

The size of the implementation foreseen also determines the potential for scale-up, taking into account the surrounding level of organisational complexity.

6.4 First thoughts on pre-requisites underlying the success factor

The availability of technical standards, both *de facto* and *de jure*, is a pre-requisite to large scale-up, when the scaling involved encompasses different health economies or healthcare organisations.

6.5 Illustration of this critical success factor from the Maccabi case

The service was scaled up within the Maccabi organisation after a pilot phase involving 1,400 patients. It reached 10,171 patients treated in July 2014 after two years of service. The fact that the large-scale deployment did not require a new health information integration or a new technological environment helped to enable the completion of the scaling-up process in only several months.

6.6 Illustration of this critical success factor from the RxEye case

The RxEye brokering platform has excellent properties which will enable it to be further scaled up as it interoperates with customer information system in a non-intrusive way (exchanging radiological image and reporting results). The earning logic depends extensively on the number of transactions made using the platform. In fact, the service has already been scaled up inside Sweden and abroad, as it has become a provider to Danish customers.

6.7 Illustration of this critical success factor from the Teledialysis case

A regional scale-up (with more local health centres being connected to the hospital) would demand the redesign of the organisation and routines according to how many simultaneous video-conferences the renal department should and can handle.

As for a broader scale-up (i.e., connection with new hospitals or regions), no particular problems are foreseen as the communication technology used is standard.

6.8 Illustration of this critical success factor from the ITHACA case

From a technological point of view, ITHACA is ready to be scaled up geographically (in other areas in the Catalonia autonomous region) and functionally (to be used for other health conditions, such as diabetes). However, this scale-up has not yet occurred, as a further scale-up agreement has so far not been possible due to differences among the ITHACA partners and their divergent interests. Actually all three partners are desirous of scaling-up the service, but in different ways. BSA would like to extend the service to more chronic care patients, while Novartis and Indra would like to offer ITHACA to other healthcare organisations worldwide.

6.9 Illustration of this critical success factor from the KSYOS case

KSYOS follow a Health Management Practice model that has been built on having four phases. These phases are: service development, usability research, efficiency research, and scale-up. The scale-up phase focused specifically on deploying KSYOS services to new clients and larger organisations.

However, from the very first phase, when the service was designed and developed, scale-up was already taken into account and outlined in the KSYOS business plan (since technology infrastructure must be supported by company growth in terms of the number of clients and services, such as teleopthamology, telecardiology, teledermatology, and telepulmonology). In KSYOS, expansion models and service adaptation were defined at the beginning of service extension.

6.10 Illustration of this critical success factor from the Cardio Online Europe case

For some years, the Cardio Online Europe service has been directed not only towards the emergency sector but also to either the severity or chronic character of the condition. Many patients need care and regular health checks, so the Puglia region decided to make the same

technologies (i.e., electrocardiograms and Holter) available to those individuals who experience an emergency event. The aim of Cardio Online Europe is not to stop at scale-up in only one region, but to extend the same service to other Italian regions. This scaling-up occurs when policy-makers and cardiologists agree, as it has been the case in the Puglia region. In 2014 Cardio Online Europe moved offices and more than tripled the size of its premises.

6.11 Lessons learned on guaranteeing that the technology has the potential for scale-up from the cases

All cases have experienced scale-up in some way. Maccabi, RxEye, KSYOS and Cardio Online Europe have deployed their service to different care teams than in the first deployment either inside the organisation (Maccabi) or to new customers (the rest of the cases). ITHACA and Teledialysis have deployed telemedicine only in a first care environment, but both had plans to scale-up from the beginning. The cases show how important it is to incorporate scale and scope in early planning stages and how this influences technology selection, procurement processes and organisational issues.

Regarding the technological market, innovative technologies may over-promise and may be risky when compared with more established technologies in terms of customer acceptability or the availability of technology providers.

Avoiding provider lock-in and assuring potential interoperability with different health information systems through the use of technology standards are two relevant lessons from the ensemble of telemedicine experiences that have been reviewed.

6.12 Overall analysis on guaranteeing that the technology has the potential for scale-up from the cases

All the cases considered an attachment to mature and standard technologies and interoperability to be fundamental in order to scale-up their solutions.

6.13 Further relevant discussion

Scalability is not only a technological issue. It also encompasses three other perspectives – geographical, functional and target perspectives. For this reason, scaling-up has to be addressed seriously from the beginning of a telemedicine project or initiative.

7. Conclusions

All five critical success factors that define the technical infrastructure and market relations block of critical success factors have been validated through the analysis and illustration of selected telemedicine cases.

The appropriateness and availability of information technology infrastructure and eHealth infrastructure was illustrated by all the cases. At the present time, technology has reached a sufficient level of maturity to allow the application of telemedicine solutions in a safe and reliable way to all types of users.

However, a difference in the upscaling approach was detected between cases based on their configuration. Private and market-oriented cases (like RxEye, KSYOS and Cardio Online Europe) followed technology standards closely and were keen to adopt interoperability standards so as to maximise their market opportunities. The public-sector promoted cases (Maccabi, Teledialysis and ITHACA), which relied on interoperability standards, in contrast needed to have a good integration with their own electronic health records and to improve their internal scaling capacities.

User-friendliness was fundamental in the design and implementation phase in all the cases to guarantee and support an easier user adoption. A different approach to usability has been identified clearly among the cases depending on their orientation in terms of end-users. Those cases typified as doctor-to-doctor telemedicine services focused on usability to avoid additional data-entry and reduce clinicians' workload while doctor-to-patient cases (such as Maccabi and ITHACA) focused on usability in terms of accessibility to patients.

The technology and processes required to provide a continuous and reliable maintenance and telemedicine service monitoring was present in all the cases. Vendor initiatives had service monitoring as a key value proposition. Healthcare providers – with the exception of ITHACA, due to its partnership with an IT company – opted to internalise the service monitoring. In all the cases, however, a good collaboration among service monitoring teams and technology providers was seen as crucial to guarantee the quality of the service.

Clarity in the procurement process and access to expert advice was in all the cases considered to be critical so as to face better future developments of the telemedicine services. A lack of guidelines in pre-commercial procurement was detected particularly in healthcare providers' initiatives (i.e., Maccabi and ITHACA).

Finally, an attachment to mature and standard technologies and interoperability was considered by all the cases to be fundamental to scaling-up their solutions.

8. Glossary: Definitions and Abbreviations

This glossary of terminology relevant to the field of technical infrastructure and market relations was developed by this special interest group 4 (SIG 4) to accompany the deliverable.

Concept	Provisional definition
ADSL	Asymmetric digital subscriber line (ADSL) is a type of digital subscriber line (DSL) technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voice band modem can provide.
CDA	Clinical Documentation Architecture. This is a document mark-up standard that specifies the structure and semantics of "clinical documents" for the purpose of exchange between healthcare providers and patients.
DICOM	Digital Imaging and Communication in Medicine.
ECG	Electrocardiography is a transthoracic (across the thorax or chest) interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the surface of the skin and recorded by a device external to the body.
HER	Electronic healthcare record.
FTP	File transfer protocol.
GPRS	General packet radio service. This is a packet-oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM).
GSM	Global System for Mobile Communications. Originally Groupe Spécial Mobile, GSM is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones.
HL7	Health Level Seven. HL7 is the global authority on standards for interoperability of health information technology.
HTTP	Hypertext transfer protocol.
IP	The Internet Protocol (IP) is the primary protocol in the Internet Layer of the Internet Protocol Suite. It has the task of delivering packets from the source host to the destination host solely based on the addresses.
LAN	Local Area Network. A local area network interconnects computers in a limited area such as a home, a clinic, or a hospital.

Concept	Provisional definition
PACS	Picture archiving and communication system.
SMS	Short message service.
SNOMED	Systematized Nomenclature of Medicine.
www	World wide web.

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