Chapter 2

Benefits Evaluation Framework

Francis Lau, Simon Hagens, Jennifer Zelmer

2.1 Introduction

The Benefits Evaluation (BE) Framework was published in 2006 as the result of a collective effort between Canada Health Infoway (Infoway) and a group of health informaticians. Infoway is an independent not-for-profit corporation with the mission to accelerate the development, adoption and effective use of digital health innovations in Canada. The health informaticians were a group of researchers and practitioners known for their work in health information technology (HIT) and health systems data analysis. These individuals were engaged by Infoway to be members of an expert advisory panel providing input to the pan-Canadian benefits evaluation program being established by Infoway at the time. The expert advisory panel consisted of David Bates, Francis Lau, Nikki Shaw, Robyn Tamblyn, Richard Scott, Michael Wolfson, Anne McFarlane and Doreen Neville.

At the time in Canada, the increased focus on evaluation of eHealth, both nationally and in the provinces and territories, reflected similar interest internationally. There was an increasing demand for evidence-informed investments, for information to drive optimization, and for accountability at project completion (Hagens, Zelmer, Frazer, Gheorghiu, & Leaver, 2015). The expert advisory panel recognized that a framework was a necessary step to convert that interest into focused action and results.

The intent of the BE Framework was to provide a high-level conceptual scheme to guide eHealth evaluation efforts to be undertaken by the respective jurisdictions and investment programs in Canada. An initial draft of the BE Framework was produced by Francis Lau, Simon Hagens, and Sarah Muttit in early 2005. It was then reviewed by the expert panel members for feedback. A revised version of the framework was produced in fall of 2005, and published
in Healthcare Quarterly in 2007 (Lau, Hagens, & Muttitt, 2007). Supporting the BE Framework, the expert panel also led the development of a set of indicator guides for specific technologies and some complementary tools to allow broad application of the framework. Since its publication, the BE Framework has been applied and adapted by different jurisdictions, organizations and groups to guide eHealth evaluation initiatives across Canada and elsewhere.

This chapter describes the conceptual foundations of the BE Framework and the six dimensions that made up the framework. We then review the use of this framework over the years and its implications on eHealth evaluation for healthcare organizations.

2.2 Conceptual Foundations

The BE Framework is based on earlier work by DeLone and McLean (1992, 2003) in measuring the success of information systems (IS) in different settings, the systematic review by van der Meijden, Tange, Troost, and Hasman (2003) on the determinants of success in inpatient clinical information systems (CIS), and the synthesis of evaluation findings from published systematic reviews in health information systems (HIS) by Lau (2006) and Lau, Kuziemsky, Price, and Gardner (2010). These published works are summarized below.

2.2.1 Information Systems Success Model

The original IS Success Model published by DeLone and McLean in 1992 was derived from an analysis of 180 conceptual and empirical IS studies in different field and laboratory settings. The original model has six dimensions of IS success defined as system quality, information quality, use, user satisfaction, individual impact, and organizational impact (Figure 2.1). Each of these dimensions represents a distinct construct of “success” that can be examined by a number of quantitative or qualitative measures. Examples of these measures for the six IS success dimensions are listed as follows:

- **System quality** – ease of use; convenience of access; system accuracy and flexibility; response time

- **Information quality** – accuracy; reliability; relevance; usefulness; understandability; readability

- **Use** – amount/duration of use; number of inquiries; connection time; number of records accessed

- **User satisfaction** – overall satisfaction; enjoyment; software and decision-making satisfaction
- **Individual impact** – accurate interpretation; decision effectiveness, confidence and quality

- **Organizational impact** – staff and cost reductions; productivity gains; increased revenues and sales

In 2003, DeLone and McLean updated the IS Success Model based on empirical findings from another 285 journal papers and conference proceedings published between 1992 and 2002 that validated, examined or cited the original model. In the updated model a service quality dimension was added, and the individual and organizational impact dimensions were combined as a single construct called net benefits (Figure 2.2). The addition of service quality reflected the need for organizations to recognize the provision of IS service support beyond the technology as a determinant of IS success. Examples of service quality measures are staff reliability, empathy and responsiveness. On the other hand, the net benefits dimension was chosen to simplify the otherwise increasing number and type of impacts being reported such as group, industry and societal impacts. Also the inclusion of the word “net” in net benefits was intentional, as it emphasized the overall need to achieve positive impacts that outweigh any disadvantages in order for the IS to be considered successful.

The IS Success Model by DeLone and McLean is one of the most widely cited conceptual models that describe the success of IS as a multidimensional construct. It is also one of the few models that have been empirically validated in numerous independent laboratory and field evaluation studies across different educational, business and healthcare settings.

![Figure 2.1. IS success model.](http://www.informs.org)

2.2.2 Clinical Information Systems Success Model

Van der Meijden et al. (2003) conducted a literature review on evaluation studies published from 1991 to 2001 that identified attributes used to examine the success of inpatient clinical information systems (CIS). The review used the IS Success Model developed by DeLone and McLean as the framework to determine whether it could correctly categorize the reported attributes from the evaluation studies. In total, 33 studies describing 29 different CIS were included in the review, and 50 attributes identified from these studies were mapped to the six IS success dimensions (Table 2.1). In addition, 16 attributes related to system development, implementation, and organizational aspects were identified as contingent factors outside of the six dimensions in the IS Success Model (Table 2.2).

Figure 2.2. Updated IS success model.

### Table 2.1
*Attributes of CIS Success Factors*

<table>
<thead>
<tr>
<th>System Quality Attributes</th>
<th>Information Quality Attributes</th>
<th>Usage Attributes</th>
<th>User Satisfaction Attributes</th>
<th>Individual Impact Attributes</th>
<th>Organizational Impact Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ease of use – (record keeping time),</td>
<td>• Completeness, Accuracy of data, Legibility, Timeliness, Perceived usefulness, Availability, Comprehensive, Consistency, Reliability, Format</td>
<td>• Number of entries, Frequency of use, Duration of use, Self-reported usage, Location of data entry, Frequency of use of specific functions</td>
<td>• User satisfaction, Attitude, User friendliness, Expectations, Competence in computers</td>
<td>• Changed clinical work patterns, Direct benefits, Changed documentation habits – (more administrative tasks, time of day for documenting, documentation frequency), Information use – (information recall, accurate interpretation, integration of information / overview, information awareness), Efficiency and effectiveness of work, Job satisfaction</td>
<td>• Communication and collaboration, Impact on patient care, Costs – (time savings, reduction of staff, number of procedures reduced)</td>
</tr>
<tr>
<td>• Response time, Time savings, Intrinsic features creating extra work, Perceived ease of use, Usability, Availability, Ease of learning, Rigidity of system – (built-in rules), Reliability, Security, Easy access to help, Data accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


### Table 2.2
*Attributes of Contingent Factors*

<table>
<thead>
<tr>
<th>System Development Attributes</th>
<th>Implementation Attributes</th>
<th>Organizational Aspects Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• User involvement, Redesign work practices, Reconstruction of content / format, Technical limitations</td>
<td>• Communication (frequency, two way), Training, Priorities chosen, Technical support, User involvement</td>
<td>• Organizational culture – (control and decision-making, management support, professional values, collaboration / communication), Support and maintenance, Champions, Rewards</td>
</tr>
</tbody>
</table>

Since its publication in 2003, the CIS Success Model by van der Meijden and colleagues (2003) has been widely cited and applied in eHealth evaluation studies. The CIS Success Model can be considered an extension of the original IS Success Model in that it recognizes the influence and importance of contingent factors related to the system development, implementation and organizational aspects that were not included in the original model.

2.2.3 Synthesis of Health Information System Reviews

Lau (2006) examined 28 systematic reviews of health information system (HIS) evaluation studies published between 1996 and 2005. From an initial synthesis on 21 of the published reviews pertaining to clinical information systems/tools and telehealth/telemedicine evaluation studies, Lau identified 60 empirical evaluation measures in 20 distinct categories of success factors based on the six IS success dimensions in the revised DeLone and MacLean model (i.e., system, information and service quality, use and user satisfaction, and net benefits). These empirical evaluation measures were reconciled with the success measures reported in the original and revised DeLone and MacLean models, as well as the attributes identified in the van der Meijden et al. model. Additional findings from the Lau review that were supplementary to the BE Framework included the clinical domains, study designs and evaluation measures used in the evaluation studies. These findings provided an initial empirical evidence base for the potential application of the BE Framework dimensions, categories and measures (Lau, 2006). Selected findings for 14 of the initial 21 systematic reviews examined are shown in Table 2.3. See also the separate additional references section for Table 2.3.
2.3 Benefits Evaluation Framework Dimensions

The BE Framework is based on all six dimensions of the revised DeLone and MacLean IS Success Model, which are system, information and service quality, use and user satisfaction, and net benefits. A total of 20 categories and 60 subcategories of evaluation measures are defined in the BE Framework. They are based on the measures identified in the van der Meijden et al. (2003) CIS Success Model and the Lau et al. (2010) HIS review synthesis. In the BE Framework, the net benefits are further grouped into three subcategories of care quality, access and productivity. These subcategories are from the original benefits measure-
ment framework defined by Infoway to determine the impact of digital health broadly on national healthcare renewal priorities (Infoway, 2005).

When creating the BE Framework, Infoway recognized the importance of organizational and contextual factors on the adoption and impact of eHealth systems. However, these factors were considered out-of-scope at the time in order to reduce the complexity of the framework. The scope was also tailored to increase its acceptance by stakeholder organizations, as many of the eHealth project teams who would be overseeing evaluation were not well positioned to investigate and report on the broader issues. The BE Framework is shown in Figure 2.3. Note that there are other measures in the IS and CIS success models that are not in the BE Framework. They were excluded for such pragmatic reasons as the perceived subjective nature of the data and the difficulty in their collection.

2.3.1 Health Information Technology Quality
There are three HIT quality dimensions, namely system, information, and service.

System quality refers to the technical aspects of the HIT and has three categories of measures on system functionality, performance and security. Functionality covers the type and level of HIT features present such as order entry with decision support for reminders and alerts. Performance covers the technical behaviour of the HIT in terms of its accessibility, reliability and response time. Security
covers the ability to protect the integrity and use of the data captured, and to ensure only authorized access to the HIT.

Information quality refers to the characteristics of the data in the system and has two categories on the quality of the content and its availability. Content covers the accuracy, reliability, completeness and comprehension of the data. Availability covers the timeliness of accessing the data when and where needed.

Service quality refers to HIT implementation, training and ongoing support by staff and has one category on responsiveness. Examples of responsiveness are the extent and adequacy of user training and technical support available. Not included are service empathy and assurance from the IS success model which were considered too subjective to evaluate at that time. Note that for each of the BE Framework dimensions and categories there are further breakdowns into subcategories and measures. See section 2.3.4 for a complete list of the defined HIT quality measures.

2.3.2 Use and User Satisfaction
The use dimension in the BE Framework has three categories which are usage behaviour and pattern, self-reported use, and intention to use. Usage behaviour and pattern cover actual HIT usage in terms of type, frequency, duration, location and flexibility. One example is the volume of medication orders entered by providers on the nursing units in a given time period. Self-reported use covers perceived HIT usage reported by users in terms of type, frequency, duration, location and flexibility. Intention to use is the proportion of and factors causing non-users of an implemented HIT to become active users of the system. The satisfaction dimension has three categories, namely competency, user satisfaction, and ease of use. Competency covers the knowledge, skills and experience of the users in the HIT. User satisfaction covers the extent to which the users feel gratified from using the HIT to accomplish their tasks. Ease of use covers the extent to which the users feel the HIT is both easy to learn and easy to use.

2.3.3 Net Benefits
The net benefits dimension has three categories of measures on care quality, access and productivity, respectively. Care quality has three subcategories: patient safety, appropriateness and effectiveness, and health outcomes. Patient safety includes adverse events, prevention, surveillance, and risk management. Appropriateness includes the adherence and compliance to benchmarks, policy or practice standards, and self-reported practices or practice profiles captured in the system. Effectiveness includes continuity of care with individuals or local/dispersed teams and referral of services. Health outcomes include short-term
clinical outcomes and longer-term change in the health status of patients attributable to HIT interventions.

Access has two subcategories that cover the ability of the patient to access care, which includes enabling access to care through technology (e.g., videoconferencing) and driving improvements in access (e.g., wait time information systems), and the extent of patient/caregiver participation in these services. Productivity has three subcategories: efficiency, care coordination, and net cost. Efficiency includes resource use, output and care continuity improvement, and health systems management capability. Care coordination includes care provision by teams and continuity of care across settings. Net cost includes monetary avoidance, reduction and saving.

2.3.4 Summary of Benefit Evaluation Measures
The BE Framework dimensions, categories, subcategories and measures are summarized in Table 2.4. Note that these are suggested measures only, and are not an exhaustive list of measures reported in the literature. Healthcare organizations may choose to adopt these measures or adapt and extend the list to include new measures to suit their needs.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Category</th>
<th>Subcategories and Definitions of Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Functionality</td>
<td>Type and level of features available (e.g., order entry and decision support)</td>
</tr>
<tr>
<td></td>
<td>Performance</td>
<td>Accessibility (remote and availability), reliability (up/down time) and system response time</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>Type and level of features available</td>
</tr>
<tr>
<td>Information</td>
<td>Content</td>
<td>Accuracy, relevance, completeness and comprehension</td>
</tr>
<tr>
<td></td>
<td>Availability</td>
<td>Timeliness, reliability and consistency of data when and where needed</td>
</tr>
<tr>
<td>Service</td>
<td>Responsiveness</td>
<td>Extent and adequacy of implementation, training and ongoing support available</td>
</tr>
<tr>
<td>Use</td>
<td>User behaviour and pattern</td>
<td>Type, frequency, duration, location and flexibility of actual usage</td>
</tr>
<tr>
<td></td>
<td>Self-reported use</td>
<td>Type, frequency, duration, location and flexibility of perceived usage</td>
</tr>
<tr>
<td></td>
<td>Intention to use</td>
<td>Reasons for current non-users to become users and proportion who do</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Competency</td>
<td>Knowledge, skills and experience of users in the HIS</td>
</tr>
<tr>
<td></td>
<td>User satisfaction</td>
<td>Extent to which the users feel gratified from using the HIS</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>User friendliness and learnability</td>
</tr>
</tbody>
</table>
Table 2.4

Summary of BE Measures

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Category</th>
<th>Subcategories and Definitions of Measures</th>
</tr>
</thead>
</table>
| Net benefits | Care Quality | Patient safety  
- preventable adverse events, near-misses and errors  
- surveillance in monitoring of specific populations for patterns and trends  
- reduction in patient risks and safety-related reportable adverse events |
|           |          | Patient safety  
a) preventable adverse events, near-misses and errors  
b) surveillance in monitoring of specific populations for patterns and trends  
c) reduction in patient risks and safety-related reportable adverse events |
|           |          | Appropriateness and effectiveness  
a) adherence and compliance with benchmark, policy or practice standards and guidelines  
b) self-reported practice or practice captured in the HIS  
c) immunization and testing and other relevant rates  
d) continuity of care, examples:  
- information, relational and management continuity  
- by individuals or multi-disciplinary or geographically dispersed teams  
- access to information and effectiveness of general practitioner and specialist referral |
|           |          | Health outcomes  
a) clinical outcomes  
b) change in health status attributable to eHealth interventions |
| Access    |          | Ability of patients and providers to access services  
a) availability, diversity and consolidation of eHealth-enabled services  
b) timeliness, geographic, financial and cultural or linguistic  
c) removal of inequitable barriers (including affordability, acceptability and accommodation)  
|           |          | Patient and caregiver participation  
a) patients’ self-management and access to their own information |
| Productivity |          | Efficiency  
a) provider resource use  
b) improvement short term outputs vs. inputs, and long term in care continuity  
c) improved health system management capability  
d) improved patient efficiency (e.g., more efficient scheduling of preoperative testing)  
e) non-monetary effects  
|           |          | Care coordination  
a) care provision by team  
b) continuity of care across continuum  
|           |          | Net cost  
a) monetary avoidance  
b) monetary reductions, actual/projected savings |

2.4 Benefit Evaluation Framework Usage
Since its debut in 2006, the BE Framework has been applied, adapted and cited in different evaluation reports, reviews, studies and commentaries. In this section we describe the companion resources that were created along with the framework. Then we summarize evaluation studies conducted in Canada that applied, adapted and cited the framework, followed by studies from other countries. Last, we include an example of a survey tool that can be used to evaluate the adoption of eHealth systems.

2.4.1 Companion Resources
The BE Framework is helpful in describing factors that influence eHealth success. But there should also be guidance and resources in place to help practitioners apply the framework in specific field evaluation studies. Guidance can be in the form of suggested evaluation questions, methods, designs and measures that are appropriate for the type of eHealth system and adoption stage involved, as well as the logistics for collecting and analyzing the data needed in the study. Another form of guidance required relates to managing evaluation activities, from structuring stakeholder engagement and gaining buy-in, to finding skilled evaluators, overseeing studies, and communicating results. Resources can be in the form of sample evaluation study plans, data collection tools, best practices in eHealth evaluation, completed evaluation reports and published peer-reviewed evaluation studies. As part of the initial release of the BE Framework in 2006, Infoway commissioned leading experts to develop indicator guides and compiled a BE Indicators Technical Report (Infoway, 2006) and a System and Use Assessment (SUA) survey tool (Infoway, 2006) as two companion resources. These resources were developed in collaboration with the Infoway BE expert advisory panel, eight subject matter experts, and two consultant teams.

The 2006 BE Indicators Technical Report (Infoway, 2006) includes a detailed description of the BE Framework, suggested evaluation questions, indicators and measures for specific eHealth programs, criteria for selecting appropriate BE indicators, and examples of tools and methods used in completed evaluation studies. The report covers six program areas, which are diagnostic imaging, drug information systems, laboratory information systems, public health systems, interoperable Electronic Health Records (iEHRs) and telehealth. These were some of the core initial investment programs funded by Infoway where it was necessary to assess tangible benefits to the jurisdictions and healthcare organizations as co-funders of these programs. Version 2.0 of the BE Indicators Technical Report was released in 2012 with expanded content (Infoway, 2012). The report still covers six program areas but laboratory information system has been merged with interoperable EHR as one section, and electronic medical records (EMR) for physician/nurse practitioner offices has been added as a new section. In Version 2.0 there are many more examples of published evaluation studies including those from Canadian jurisdictions and healthcare organizations. A BE planning template has also been added to facilitate the creation of a
practical evaluation plan for any eHealth system, and provide some of the practical guidance on managing evaluation activities. Since the publication of Version 2.0, additional program indicator sets and tools have been developed for telepathology, consumer health solutions and ambulatory EMR.

The SUA survey tool was introduced in 2006 as a multipart semi-structured questionnaire to collect information from users on the quality of the eHealth system and its usage in the organization. The questionnaire has since been adopted as a standardized Infoway survey tool to collect comparable information on the quality and use of eHealth systems being evaluated in Canada (Infoway, 2012). The SUA survey tool is aligned with the HIT quality, use and satisfaction dimensions of the BE Framework in terms of the questions used. The current version of this survey tool has eight sections of questions and guidance on how to administer the survey and analyze the results for reporting. These sections are on overall user satisfaction, system quality, information quality, service quality, public health surveillance, system usage, other comments, and demographic information. The survey can be adapted or expanded to include specific questions tailored to a particular eHealth system, such as the perceived accuracy of the images from the diagnostic imaging system being evaluated (Infoway, 2012).

2.4.2 Benefit Evaluation Framework Usage in Canada

Over the years, the BE Framework has been applied in over 50 evaluation studies across Canada. As examples, Table 2.5 shows 13 Canadian evaluation studies conducted over the past six years. See also the separate additional references section for Table 2.5. Six of these studies were related to telehealth, covering such clinical areas as ophthalmology, oncology and chronic disease management (British Columbia Ministry of Health [MOH], 2011a; B.C. MOH, 2011b; Gartner Inc., 2013; Praxia Information Intelligence & Gartner, Inc., 2010; Ernst & Young, 2014; Newfoundland and Labrador Centre for Health Information [NLCHI], 2010). Two studies covered drug information systems (Deloitte, 2010; Gartner Inc., 2013). Two studies covered diagnostic imaging systems (Gartner Inc., 2013; Hagens et al., 2009a). Two studies were on EMR systems for ambulatory and community care settings, respectively (PricewaterhouseCoopers [PwC], 2013; MOH, 2014). There was also one study each on vaccine inventory management (B.C. MOH, 2013), electronic occurrence reporting for patient safety (Elliot, 2014) and SNOMED (Systematized Nomenclature of Medicine) Clinical Terms (CT)¹ use in palliative care (Lau, 2010).

¹ In 2014, the International Health Terminology Standards Development Organisation (IHTSDO) responsible for SNOMED CT officially changed the name so SNOMED CT no longer refers to Systematized Nomenclature of Medicine Clinical Terms, but rather just SNOMED Clinical Terms. It has become a trade name rather than an acronym.
Most of these evaluation studies focused on satisfaction, care quality, productivity and access dimensions of the BE Framework, with the addition of measures specific to eHealth systems as needed. Examples include turnaround time for imaging test results, patient travel time and cost, and SNOMED CT term coverage in palliative care. Most studies used mixed methods to collect and analyse data from multiple sources. Reported methods include survey, interview, literature review, service data analysis and modelling of benefit estimates. Reported data sources include provider and patient surveys, interview and focus group data, service utilization data, prior evaluation reports and published peer-reviewed evaluation studies and systematic reviews. Note that many of the evaluation studies were based on perceived benefits from providers and patients, or projected benefits based on model cost estimates.

The BE Framework has also been cited in a number of Canadian evaluation studies, commentaries and student reports. For instance, in their evaluation of a provincial drug information system, Mensink and Paterson (2010) adapted the use and satisfaction dimensions of the BE Framework to examine its adoption and evolution over time. Similarly Shachak et al. (2013) extended the HIT service quality dimension to include different end user support themes such as onsite technical and data quality support by knowledgeable staff. In their commentary on EHR success strategy, Nagle and Catford (2008) emphasized the need to incorporate benefits evaluation as a key component toward EHR success. O’Grady and colleagues (2009) discussed collaborative interactive adaptive technologies (e.g., social media). Six graduate-level theses that drew on the BE Framework have also been published. These include the evaluation studies on: a scanning digital prescriber order system by Alsharif (2012); end user support for EMR by Dow (2012); electronic occurrence reporting on patient safety by Elliot (2010); EMR implementation in an ambulatory clinic (Forland, 2008); a multidisciplinary cancer conferencing system detailed by Ghaznavi (2012); and characteristics of health information exchanges in literature (Ng, 2012).
### Table 2.5

Examples of Canadian Evaluation Studies where the BE Framework was Applied

<table>
<thead>
<tr>
<th>Authors</th>
<th>Setting</th>
<th>eHealth system</th>
<th>Evaluation Focus</th>
<th>Design/Methods</th>
<th>Indicator/Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.C. MOH (2011a)</td>
<td>Six health regions in British Columbia</td>
<td>Telehealth system for specialized oncology consults, provider education</td>
<td>Access to oncology service and provider education, travel time and cost</td>
<td>Patient and physician surveys, analysis of utilization</td>
<td>Consult/education service counts, travel time, patient and physician satisfaction</td>
<td>Interim results showed increased access, reduced travel time, high satisfaction level for patients and providers</td>
</tr>
<tr>
<td>B.C. MOH (2011b)</td>
<td>Two health regions in British Columbia</td>
<td>Telehealth system for ophthalmology retinal screening</td>
<td>Telehealth quality, use, satisfaction, access, productivity, empowerment</td>
<td>Survey, pre/post service use</td>
<td>System function, info quality, usability, travel time, patient volume, satisfaction, change in # diabetic and retinal screening</td>
<td>100% satisfied with telehealth quality and use, some travel cost saving, fee code and improved scheduling to maximize service</td>
</tr>
<tr>
<td>B.C. MOH (2013)</td>
<td>Four health regions in British Columbia</td>
<td>Panorama vaccine inventory module</td>
<td>Productivity, module usability, adoption, support mechanisms</td>
<td>Survey and interview</td>
<td>Staff time efficiency, vaccine wastage cost and volume</td>
<td>Some benefits, below expectations, need to streamline steps, expand functions/use</td>
</tr>
<tr>
<td>Cousins and Baldwin (2014)</td>
<td>Ambulatory clinics in provincial region in British Columbia</td>
<td>eChart/EMR</td>
<td>Key performance indicators for eChart</td>
<td>Survey, chart review, focus group, document review</td>
<td>eChart quality, usage, satisfaction, medication alerts, patient/family experience</td>
<td>Overall satisfied – 42%, quality acceptable – system 50%, info 63%, productivity +/- 10%</td>
</tr>
<tr>
<td>Deloitte (2010)</td>
<td>Pan-Canadian</td>
<td>Generation 2 drug info systems</td>
<td>Expected benefits in quality and productivity, focus on safety</td>
<td>Prior evaluations, survey, interviews, utilization analysis, benefits modelling</td>
<td>Adverse drug events and admissions, med abuse, compliance, productivity</td>
<td>Estimated benefits $436m: quality $252m, productivity $184m</td>
</tr>
</tbody>
</table>
Table 2.5
Examples of Canadian Evaluation Studies where the BE Framework was Applied

<table>
<thead>
<tr>
<th>Authors</th>
<th>Setting</th>
<th>eHealth system/Description</th>
<th>Evaluation Focus</th>
<th>Design/Methods</th>
<th>Indicator/Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elliot et al. (2014)</td>
<td>One health region in Newfoundland and Labrador</td>
<td>Electronic occurrence reporting system (aka clinical safety reporting system)</td>
<td>Benefits and lessons</td>
<td>Mixed methods, pre/post design, surveys, interviews, focus groups, cases reported, project documents</td>
<td>Pre/post adoption cases reported, time to reporting, usability and satisfaction</td>
<td>Increased reporting, improved notification, satisfaction, issues in implementation</td>
</tr>
<tr>
<td>Ernst &amp; Young (2014)</td>
<td>Pan-Canadian, based on 4 programs</td>
<td>Remote patient monitoring (RPM) systems</td>
<td>Expected benefits in care quality, access and productivity</td>
<td>Utilization data, literature review, interviews, surveys</td>
<td>Utilization, break-even, cost, caregiver burden, satisfaction, compliance</td>
<td>Moderate evidence on benefits especially larger scale programs, solutions emerging</td>
</tr>
<tr>
<td>Gartner, Inc. (2013)</td>
<td>British Columbia, province-wide</td>
<td>Diagnostic imaging, Drug info systems, telehealth systems</td>
<td>Estimated benefits in care quality, access and productivity</td>
<td>Estimates from pan-Canadian studies, B.C. data and interviews</td>
<td>Expected cost saving, productivity, patient transfer, satisfaction, adverse events, callbacks, medication abuse, compliance, travel time, access</td>
<td>Expected improvement in care quality, access and productivity in DI at $90m, DIS at $200m and telehealth at $15m</td>
</tr>
<tr>
<td>Hagens et al. (2009a, 2009b)</td>
<td>Pan-Canadian based on 4 provinces</td>
<td>Diagnostic imaging systems</td>
<td>Estimated benefits in quality, access and productivity</td>
<td>Mixed methods, pre/post adoption survey, utilization</td>
<td>Turnaround time, transfers, duplicate exams, productivity, communication, cost per case</td>
<td>Estimated benefits in improved access 30-40%, efficiency $160-190m, turnaround time 41%, productivity 25-30% at $122-148m</td>
</tr>
<tr>
<td>Lau et al. (2010)</td>
<td>Palliative care program in one region</td>
<td>Palliative care info system (PCIS)</td>
<td>SNOMED CT quality and use in palliative care</td>
<td>Mixed methods, interviews, case analysis and system usability</td>
<td>SNOMED CT quality, use/satisfaction, care quality, productivity</td>
<td>Higher consistency with SNOMED encoded consult letter with better quality</td>
</tr>
</tbody>
</table>
2.4.3 Benefit Evaluation Framework Usage in Other Countries

The BE Framework has also been adapted or cited by health informaticians from other countries in their eHealth evaluation work. In New Zealand, for example, Warren, Pollock, Day, Gu, and White (2011) and Warren, Gu, Day, and Pollock (2012) have incorporated the BE Framework as part of their standardized criteria pool of evaluation measures to be used selectively when evaluating eHealth systems. The criteria pool covers work and communication patterns, organizational culture, safety and quality, clinical effectiveness, IT system integrity, usability, vendor factors, project management, participant experience, and leadership and governance. Warren and colleagues advocated the use of action research to conduct evaluation based on a select set of evaluation measures from the criteria pool. This approach has been applied successfully in the evaluation of electronic referral systems (Gu, Warren, Day, Pollock, & White, 2012; Warren et al., 2012).

In their literature review of routine health information systems (RHIS) in low- and middle-income countries, Hotchkiss, Dianna, and Foreit (2012) examined nine conceptual frameworks including the BE Framework for adaptation to evaluate the performance of RHIS and their impact on health system functioning. Ahmadi, Rad, Nilashi, Ibrahim, and Almaee (2013) applied a fuzzy model called
Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) to identify the 10 most important factors in hospital EMR adoption based on 23 factors derived from the BE Framework. In addition, the evaluation toolkit for health information exchange projects from the United States Agency for Healthcare Research and Quality references a number of the measures from the BE Indicators Technical Report (Infoway, 2006) as recommendations for U.S. health information exchange projects (Cusack, Hook, McGowan, Poon, & Atif, 2010). A summary on the use of the BE Framework by these authors is shown in Table 2.6. See also the separate additional references section for Table 2.6.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Setting</th>
<th>eHealth system</th>
<th>Evaluation Focus</th>
<th>Design/Methods</th>
<th>Indicators/Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmadi et al. (2013)</td>
<td>Malaysia Private hospital</td>
<td>EMR systems</td>
<td>Ranking of most important factors in BE Framework</td>
<td>Survey, modeling with fuzzy technique for order performance by similarity to ideal solution (TOPSIS)</td>
<td>Likert-scale surveys with 23 parameters in 6 dimensions</td>
<td>10 important factors were patient choice, use strategies, ease of use, use intent, safety, communication, template, downtime, cost savings/profits</td>
</tr>
<tr>
<td>Cusack et al. (2010)</td>
<td>United States Multiple provider groups and healthcare organizations</td>
<td>Health information exchange (HIE)</td>
<td>Evaluation toolkit used to create an evaluation plan for HIE projects</td>
<td>A step-by-step process to determine HIE project goals and feasible measures</td>
<td>Measures for the process of creating a HIE and types of data used; and clinical process and outcome measures for the value proposition of HIE</td>
<td>Example measures listed in Sections II and III that are drawn from the BE Technical Indicators Report (2006)</td>
</tr>
<tr>
<td>Gu et al. (2012)</td>
<td>New Zealand Two health regions</td>
<td>Electronic referral in colorectal domain</td>
<td>Comparing two knowledge engineering (KE) project approaches</td>
<td>Mixed methods comparison of two cases</td>
<td>Criteria pool based on BE Framework dimensions</td>
<td>BE Framework guided examination of development approach, KE products, uptake and acceptance</td>
</tr>
</tbody>
</table>
2.4.4 System and Use Assessment Survey Tool Usage

The System and Use Assessment (SUA) survey tool has been applied in different eHealth evaluation studies across Canada. Recent examples include the evaluation of teleophthalmology and vaccine inventory management systems (Ministry of Health [MOH], 2011, 2013) and eChart (Cousins & Baldwin, 2014) in British Columbia, shared EHR in a western jurisdiction (Kuhn & Lau, 2014), and the drug information system in Prince Edward Island (Prince Edward Island [P.E.I.], 2010). A summary of these evaluation studies and how the survey tool was applied is shown in Table 2.7. See also the separate additional references section for Table 2.7.

There are also evaluation studies where the SUA survey has been adapted or cited. For instance, one Canadian jurisdiction – Nova Scotia – adapted the SUA survey tool to include more specific questions in the evaluation of their interoperable EHR picture archival and communication (PAC) and diagnostic imaging (DI) systems (for details, see Newfoundland and Labrador Centre for Health Information [NLCHI], 2014). Many of these studies are also available on the
Canada Health Infoway website. Other Canadian researchers adapted the survey tool to examine the quality and use of physician office EMRs (Paterson et al., 2010). In the United States, Steis et al. (2012) adapted the survey tool to examine user satisfaction with an electronic dementia assessment tool. In Saudi Arabia, Bah et al. (2011) adapted the tool to determine the level and extent of EHR adoption in government hospitals.

Table 2.7

<table>
<thead>
<tr>
<th>Authors</th>
<th>Setting</th>
<th>eHealth system</th>
<th>Evaluation Focus</th>
<th>Design/Methods</th>
<th>Indicators/Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.C. MOH (2011)</td>
<td>Two health regions</td>
<td>Telehealth system for ophthalmology retinal screening</td>
<td>Telehealth quality, use, satisfaction, access, productivity, empowerment</td>
<td>Survey, pre/post service use</td>
<td>System function, info quality, usability, travel time, patient volume, satisfaction, change in # diabetic and retinal screening</td>
<td>100% satisfied with telehealth quality and use, some travel cost saving, fee code and improved scheduling to maximize service</td>
</tr>
<tr>
<td>B.C. MOH (2013)</td>
<td>Four health regions</td>
<td>Panorama vaccine inventory module</td>
<td>Productivity, module usability, adoption, support mechanisms</td>
<td>Survey and interview</td>
<td>Staff time efficiency, vaccine wastage cost and volume</td>
<td>Some benefits, below expectations, need to streamline steps, expand functions/use</td>
</tr>
<tr>
<td>Cousins and Baldwin (2014)</td>
<td>Ambulatory clinics in provincial health authority</td>
<td>eChart/EMR</td>
<td>Key performance indicators for eChart</td>
<td>Survey, chart review, focus group, document review</td>
<td>eChart quality, usage, satisfaction, patient flow, medication alerts, patient/family experience</td>
<td>Overall satisfied – 42%, quality acceptable - system 50%, info 63%, productivity +/- 10%</td>
</tr>
<tr>
<td>Kuhn and Lau (2014)</td>
<td>A western jurisdiction</td>
<td>Web-based shared EHR system</td>
<td>Use, satisfaction and impact of EHR</td>
<td>Survey and system use log</td>
<td>Adoption level, user satisfaction, impact</td>
<td>Info sharing improved, usage increased, issues with access, workflow integration</td>
</tr>
</tbody>
</table>
2.5 Implications

The BE Framework has proved to be a helpful conceptual scheme in describing and understanding eHealth evaluation. The BE Indicators Report and the SUA survey tool have become useful resources for healthcare organizations to plan and conduct evaluation studies on specific eHealth systems. The published evaluation studies that incorporated the BE Framework have provided a growing empirical evidence base where such studies can be reported, compared and aggregated over time. That said, there are both conceptual and practical implications with the BE Framework that should be considered. These implications are described below.

2.5.1 Conceptual Implications

There are conceptual implications related to the BE Framework in terms of its scope, definition and perspective. For scope, the BE Framework has purposely excluded organizational and contextual factors to be manageable. Note that the IS success model by DeLone and McLean (1992, 2003) has also made no mention of organizational and contextual factors. There was an assumption in that work that the IS involved were mature and operational systems with a stable user base, which made adoption issues less central. Yet many healthcare organizations are continuing to adopt and/or adapt eHealth systems due to changing legislation, strategies and technologies. As such, organizational and contextual factors can have a great deal of influence on the success of these eHealth systems. This limitation is evident from the contingent factors identified in the CIS
review by van der Meijden et al. (2003) and in the published evaluation studies from Canada and elsewhere.

This gap was one of the drivers for the development of the complementary National Change Management (CM) Framework (Infoway, 2012). Infoway facilitated the development of this framework through the pan-Canadian Change Management Network, with the intent of providing projects with practical tools to successfully implement eHealth change. Measurement is at the centre of the framework, surrounded by governance and leadership, stakeholder engagement, communications, training and workflow analysis and integration. Infoway has encouraged the use of the BE and CM frameworks in concert.

For definition, while the BE Framework dimensions, categories and measures have been established from empirical evidence over time, they are still concepts that can be interpreted differently based on one’s experience and understanding of the meaning of these terms. In addition, the evaluation measures in the BE Framework are not exhaustive in what can be measured when evaluating the adoption and impact of myriad eHealth systems in different healthcare settings. As such, the caveat is that the definition of concepts and measures can affect one’s ability to capture key aspects of specific eHealth systems for reporting, comparison and aggregation as part of the growing eHealth evidence base.

For perspective, it should be made clear that benefits evaluation and eHealth success are concepts that are dependent on the views and intentions of the stakeholders involved. There are many questions concerning what is considered “success” including: Who defines success? Who benefits from success? What is the trade-off to achieve success? These are questions that need to be addressed early when planning the eHealth system and throughout its design, implementation and evaluation stages. In short, the BE Framework can be perceived differently according to the various perspectives of stakeholders.

2.5.2 Practical Implications

There are also practical implications with the BE Framework in terms of how it is applied in real-life settings. One question raised frequently is how one should apply the framework when planning an evaluation study in an organization. To do so, one needs to consider the intent of the evaluation with respect to its focus, feasibility and utility.

For focus, one should identify the most important questions to be addressed and prioritize them accordingly in the evaluation. The BE Framework has a rich set of measures covering different aspects of eHealth adoption and impact, but one should not attempt to include all of them within a single study. For instance, if the focus of a study is to demonstrate the ability of an eHealth system to reduce medication errors, then one should select only a few key patient safety measures such as the incidents of adverse drug events reported over two or more time periods for comparison.

For feasibility, one should determine the availability of the data for the measures needed in the evaluation, as well as the time, resources and expertise avail-
able to design the study, collect and analyze the data, and report on the findings. For example, randomized controlled trials are often considered the gold standard in evaluating healthcare interventions. Yet it may be infeasible for the organization that is implementing an eHealth system to conduct such a trial since it is still adjusting to the changes taking place with the system. Similarly, an organization may not have the baseline data needed or the expertise available to conduct evaluation studies. In these situations the organization has to decide how feasible it is to capture the data or acquire the expertise needed. Capacity to conduct evaluation is another feasibility consideration, as more complex evaluations may require specialized skill sets of evaluators, funding, leadership support or other inputs that are limiting factors for some organizations.

For utility, one needs to determine the extent to which the evaluation efforts and results can inform and influence change and be leveraged for added value. The planning and conduct of an evaluation study can be a major undertaking within an organization. Executive and staff commitment is necessary to ensure the results and issues arising from the study are addressed to reap the benefits to the system. To maximize the utility of an evaluation study and its findings, one should systematically document the effort and results in ways that allow its comparison with studies from other organizations, and aggregation as part of the evolving empirical evidence base.

2.6 Summary

This chapter described the BE Framework as a conceptual scheme for understanding eHealth results. The framework has six dimensions in system, information and service quality, use and satisfaction, and net benefits, but organizational and contextual factors are considered out-of-scope. Since its debut in 2006, the BE Framework has been applied, adapted and cited by different jurisdictions, organizations and groups in Canada and elsewhere as an overarching framework to plan, conduct and report eHealth evaluation studies. Additional studies continue to be published on a regular basis. Recognizing its limitations in addressing contexts, there is a growing evidence base in the use of the BE Framework to evaluate the success of eHealth systems across different healthcare settings.
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**Table 2.5**


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