A comprehensive framework based on Balanced Score Card(BSC) for measuring the impact of information technology and information system (IT/IS) on organization and applying it with rule-based expert system

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Abstract
Nowadays organization's investments in IT/IS area are growing and it brings managers with justifying those investments and tracking their impacts. Many researchers have tried to develop measurement and evaluation tools for helping them but due to complexity of problem, they did not measure all aspects of it. In this paper, we review comprehensively IT/IS success, impact, business value in MIS field and based on the past BSC uses for IT/IS performance evaluation, develop a comprehensive model based on IT/IS BSC perspectives. The final model assesses a broad range of IT/IS impacts on organization. Finally we apply it in expert system for practical uses. We believe that model and developed expert system can be used in organizations for tracking IT/IS investments impacts and justifying them
Keywords: IT/IS Success, IT Business value, Balanced Scorecard, expert system

1-Introduction

Growing amounts of intellectual and financial capital are being invested to collect, process, store, and disseminate information. As the resource commitments to information systems IS continue to escalate, the following types of questions are being asked more frequently than ever before: Is that investment in IS or information technology IT really worthwhile? Is that IT application we implemented asuccess? Is our IS department or function productive and effective? Should we use outsourcing? [1 p .71] At another level of analysis, the *productivity paradox* or Simply stated, the huge overall investment in computer and telecommunication technologies does not appear to have significantly raised economic productivity or corporate profits, has become a contentious issue among both economists and the IS community. Managers have found it difficult to demonstrate tangible returns on the resources expended to plan, develop, implement and operate computer-based IS. Those examples reflect the fact that recently-implemented, computer-based IS enhance value in ways that are not captured by conventional input–output accounting methods.[1 p .72] Considerable resources, invested by organizations in information systems (IS), stress the importance of success evaluation for both practitioners and researchers. [2 p.103] Traditionally managers have only focused on the economic returns of IT/IS investments [2, 3]. However, many researchers believe that traditional appraisal techniques are myopic for the appraisal of complex technology investments[2, 4]. But how can organizations compare a strategic investment in IT/IS which has a range of intangible and uncertain benefits with other corporate investments whose benefits are more tangible?[2]
Many methods and techniques have been suggested over the years to evaluate the investments made in IT and IS. Traditional methods focus on well-known financial measures, such as the return on investment (ROI), net present value (NPV), the internal rate of return (IRR), and the payback period. These methods are best-suited to measure the value of simple IT applications, such as transaction processing and office automation systems. The aforementioned types of IS were often the first to be introduced in a given organization.

Unfortunately, evaluation methods that rely on financial measures are not as well-suited for newer generations of IT applications. These computer-based IS typically seek to provide a wide range of benefits, including many that are intangible in nature. For example, it is difficult to quantify the full value of a decision support system [1,5]. The productivity paradox has prompted calls for new approaches to measure and evaluate IT-related investments [1,6,7]. According to the above mentioned states, in this article we are going to develop a comprehensive model based on Balanced Score Card (BSC) and qualitative framework to capture all tangible and intangible IT/IS impacts on organization.

2-Literature Review

2-1 IT/IS Business value and IS Success: One concept different terms

Cronk and Fitzgerald [8] stated that absence of an adequate definition of "IS business value" is a major omission in this research area. the term "IS business value" had its roots in the IS effectiveness literature of the 1980s and its meaning has been evolving through the 1990s. They stated that part of the current confusion may be due to the plethora of terms used to describe the concept. These include IS effectiveness [9], IS success [10], IS influence [11], IS impact [12, 13], and "IS business value" [14, 15]. However, of all these terms, common usage suggests that IS effectiveness and "IS business value" are the most closely related. As can be seen, however earlier definitions of IS effectiveness which looked at the more localised immediate effect of a given information system, the focus of later definitions moving more to organizational concerns [8].

DeLone and McLean's [10] model is considered the most comprehensive information system assessment model available in the information system literature [16]. DeLone and McLean's [10] conceptual model of IS success has been cited in over 300 refereed journal articles since its inception [17, 18]. Attempting to bring synthesis to the numerous IS success measures used over the years, DeLone and McLean reviewed one hundred IS success articles published in the 1980s. As a result, DeLone and McLean proposed six dimensions representing the three levels of IS success: system quality, information quality, use, user satisfaction, individual impact, and organizational impact[18]. In their recent paper, they discuss many of the important IS success research contributions of the last decade, focusing especially on research efforts that apply, validate, challenge, and propose enhancements to the original model and propose an updated DeLone and McLean IS Success Model [17 p.9]. They stated that emrgence of END USER COMPUTING in the mid-1980s placed IS organizations in the dual role of *information provider* (producing an information product) and *service provider* (providing support for end user developers), based on Pitt et al[19].observation that "commonly used measures of IS effectiveness focus on the products rather than the services of the IS function" and other researchers[20, 21, 22] added a service quality measure to their IS success model [17 p.18]. They also stated however additional IS impact measures, such as work group impacts, interorganizational and industry impacts being proposed, they prefered to move in the opposite direction and group all the "impact" measures into a single impact or benefit category called "net benefits." [17 p.19] Their updated model has six dimensions: service quality, system quality, information quality, use, user satisfaction, net benefits.

Seddon et.al [23] proposed a two-dimensional matrix for classifying IS Effectiveness measures. The first dimension is the type of system studied. The second dimension is the stakeholder in whose interests the system is being evaluated. The matrix was tested by using it to classify IS effectiveness measures from 186 empirical papers in three major IS journals for the last nine years. The results indicate that the classifications are meaningful. Their framework is based on the seven

questions shown in Table 1 that organizational psychologists, Cameron and Whetten [24, p. 270-274], argue must be answered when measuring organizational effectiveness.

Table 1: Seven Questions to Answer when Measuring Organizational Performance

No	Question from Cameron and Whetten [24]	This study 's view
1	From whose perspective is effectiveness being judged?	Management or Owners
2	What is the domain of activity?	All IT applications used by an organization or sub-organization(from Seddon et.al[23])
3	What is the level of analysis	Organizational Level(Focus on Organization better-offness from Seddon et.al[23])
4	What is the purpose of evaluation?	Justifying and planning future IT investments, Tracking IT investments impact, Identify strengths and weaknesses
5	What is time frame is employed? (short, long)	Periodically, ranging from quarterly to annually.
6	What types of data are to be used? (objective or perceptual)	Subjective; perceptual data from individuals
7	Against which referent is effectiveness to be judged?	Past performance measures

They stated that all seven questions in Table 1 are just as relevant for measuring IS Effectiveness and it is convenient to combine questions 1 and 3 in one dimension, which we call Stakeholder. A stakeholder is a person or group in whose interest the evaluation of IS success is being performed.[23 p.5] Based on the question 2 in Table 1 a second dimension defined, system, that is used to classify the type of system that is being evaluated. Classifying IS effectiveness measures by these two dimensions results in the 5*6 = 30 possible classes of measures. [23 p.6] Measures of effectiveness appropriate for one cell might be quite inappropriate for another. [23 p.8] The core message of them was that very different measures are necessary for measuring IS Effectiveness in different contexts and seven questions in Table 1 together with the matrix provides a useful framework for selecting *appropriate* measures for future IS research. [23 p.8] In this article, we considered D&M original and updated IS Success model. They recommend the use of tested and proven measures from existing research, thus we reviewed IS Success and IS Effectiveness literature and identified validated and tested measured in those area. Then for selecting appropriate measures, we considered Cameron and Whetten [24] 7 question and Seddon et.al[23] two-dimensional matrix. Our study's view or reply for those 7 questions is presented in Table 1. Also our framework's position in Seddon et.al[23] 's matrix is 4th column and 4th Row which means our stakeholders are managers and owners and we consider all IT applications used by an organization or sub-organization.

2-2 Balanced Score Card (BSC)

The BSC is a performance measurement framework, introduced by Kaplan and Norton [25] to allow managers to look at their business performance from four performance perspectives: internal business, financial, customer and innovation and learning. The BSC attempts to integrate all the interests of key stakeholders (e.g., managers, customers, employees, etc.) on a scorecard. The term '***balanced***' in the name reflects the balance provided between short- and long-term objectives, between quantitative and qualitative performance measures, and between different performance perspectives. The diverse interests and measures are categorized in the above-mentioned four performance perspectives of the scorecard [26 p.148]. The BSC concept can also be applied to measure, evaluate and guide activities that take place in specific functional areas of a business.[1 p.75]

Recently, they proposed the BSC not only as a tool for clarifying and communicating strategy, but also as a foundation for actively managing it [1p.74].

2-3 Frameworks based on BSC for measuring and evaluating IT/IS

The application of the BSC has been examined in the context of IT and information systems [28]. Van Grembergen and van Bruggen [27] show that the BSC model can be applied to the IT function. Donald et.al [28]based on the Kaplan and Norton's balanced scorecard and with Zuboff's automate, informate and transformate goals of information systems developed a framework for measuring measuring the contributions and impacts of ERP systems on the strategic goals of the company. In summary they combining Zuboff's three levels, automate, informate and transformate, with the four balanced scorecard dimensions of benefits generates a very useful 12 cells framework to explain, understand and identify the direct and indirect contributions of ERP implementations. Martinsons et.al [1 p.73] based on this suggestion[29] that the BSC may also help managers evaluate IT investments, as well as the performance of an IS organization, described how the BSC can serve as a decision support tool for IS managers. Norton. The changes stem from their view for Kaplan and Norton perspectives and measures were:

1. The IS department is typically an internal rather than external service supplier
2. IS projects are commonly carried out for the benefit of both end-users *and* the organization as a whole rather than individual customers within a large market

And they proposed below four perspectives for IS balanced IS scorecard:

1. User orientation: end-users' view
2. Business value: management's view
3. Internal processes: operations-based view
4. Future readiness: innovation and learning view

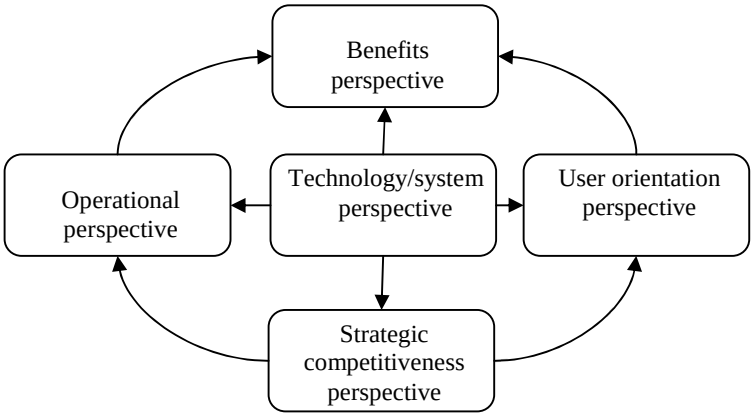
Then, they by reviewing IS literature proposed measures for each of those perspective.[1 p.75] Stewart and Mohamed[26 p.148] suggests that the BSC has the potential to help organizations evaluate their IT/IS investments, in a holistic manner, through the process of measuring and benchmarking induced performance improvement. They developed a performance measurement framework based on BSC for IT/IS by using AHP (analytic hierarchy process) and MAUT(multi-attribute utility theory) which allows for the measurement of IT/IS performance at three different decision-making tiers. By reviewing a IT/IS '*business value*' evaluation literature, twenty-five indicators were listed and selected and then by statistical factor analysis they were grouped. That statistical analysis has led to the following five performance measurement perspectives:

1. Operational perspective: This perspective replaces the 'internal business' perspective of the BSC. This perspective is mainly concerned with the integration of IT/IS into the organization and the role it plays in process co-ordination and integration between the organization and its counterparts.
2. Benefits perspective: This perspective replaces the 'financial' perspective of the BSC. The generic term 'benefits' goes beyond traditional financial measures (i.e., NPV, ROI, IRR) to encompass the many nonmonetary or intangible benefits derived by IT/IS implementation.
3. User orientation perspective: This perspective replaces the 'customer' perspective of the BSC. The term 'user orientation' has been adopted for this perspective to broaden the original customer focus to include the internal as well as external customers (users) that are actively using the IT/IS application or its output.
4. Strategic competitiveness perspective: This perspective replaces the 'innovation and learning' perspective of the BSC. This perspective differs from the 'benefits'

perspective by focusing on the long-term strategic goals of the organization and how the newly implemented technology creates competitive advantage in the future.

5. Technology/system perspective: In addition to the above four BSC perspectives, the technology/system perspective was included to encourage focusing on the technical elements of the IT/IS being implemented by the organization. This perspective refers to the technical system. This is the centre of the BSC framework since the remaining four perspectives are expected to relate to the performance of the technology/system.[26]

BSC developed for IT/IS performance evaluation from[26]



2-4 Expert systems

Knowledge Based Systems (KBS) are useful tools for decision making in the time of disaster and crisis. Expert Systems (ES) are a branch of applied Artificial Intelligence (AI), and were developed by the AI community in the mid-1960s. The basic idea behind ES is simply that expertise, which is the vast body of task-specific knowledge, is transferred from human to computer. This knowledge is then stored in the computer and users call upon the computer for specific advice as needed. The computer can make inferences and arrive at a specific conclusion. Then like a human consultant, it gives advices and explains, if necessary, the logic behind the advice [30]. Expert system is a powerful tool for solving different problems which the traditional methods are not able to solve [31]. Therefore they are used in many parts of our society and their application in decision support and problem solving is vital [30]. Expert systems are classified to eleven categories such as rule based systems, knowledge based systems, neural network and Fuzzy Expert Systems. Expert system comprises four main parts:

1. The knowledge base
2. The inference engine
3. The user interface
4. the knowledge acquisition system and the knowledge engineer[31]

3-A comprehensive framework for measuring and evaluating IT/IS

Based upon the Stewart and Mohamed [26] IT/IS performance evaluation framework and original and updated D&M IS Success model [10, 17] and other researches in IS success and IS Effectiveness literature, we developed a framework and model for assessing tangible and intangible IT/IS benefits for organization. BSC based perspectives for measuring IT/IS impacts and past used studies are shown in Table 2. In the next section we provide a brief description for measures and studies which used for the model development. Due to the model scale we could not present it here, but we present some parts of it in Appendix.

Table 2: Perspectives for measuring IT/IS impacts and past studies and their variables

No	Perspective	Relative variables and perspectives of original[10]/ updated[23] D&M IS Success model	Validated measures uses in developing comprehensive framework
1	Technology/System perspective	Information quality[14,23], System quality[14,23], Service quality[23]	19,36
2	User orientation perspective	User satisfaction[14,23], Use[14,23], Individual Impact[14]	43,46, 52
3	Organizational benefits/ value perspective	Organizational Impact[14], Net Benefits[23]	53,54
4	Internal Processes/Operational perspective	-	58
5	Future preparation perspective	-	59,60

3-1 Technology/System perspective

In original D&M IS Success model[10], "Information quality" and "System quality" and in Updated D&M IS success model[23], "Information quality" and "System quality" and "Service quality" are related to the operational perspective. Thus for measuring IS internal processes and IS products and Services, we must measure and evaluate "Information quality" and "System quality" and "Service quality":

- IS service quality: Pitt et.al [19] stated that over the last decade within the organization has broadened considerably and in addition to development and operation of IS, it has much broader role and IS Service need to be additional IS Success measure. According to the Parasuraman et.al [32,33,34] and his colleagues [35], they proposed a 45 items, SERVQUAL, for measuring IS Service quality and tested and validated it. Service quality can be assessed by measuring customer's expectations and perceptions of performance levels for a range of service attributes. Then the difference between expectations and perceptions can be calculated and averaged across attributes. According to the acceptance of this measure, it used for this dimension.
- System and Information quality: Bailey and Pearson's[36] instrument is widely accepted, has been tested for reliability and validity by several researchers [37,38,39,40,41,42], and has become a standard instrument in the MIS field. System and Information quality are operationalized with it.

3-2 User orientation perspective

In original D&M IS Success model[10], "Use", "user satisfaction" and "Individual impact" and in Updated D&M IS success model[23], "Use" and "user satisfaction" dimensions are related to the user orientation perspective. Thus for measuring user orientation, we measure and evaluate "Use", "user satisfaction" and "Individual impact":

- IT/IS Use: Doll and Torkzadeh [43] developed a 30 items multidimensional measures for measuring how extensively information technology is utilized in an organizational context for decision support, work integration, and customer service functions. They based on the Hirschhorn and Farduhar[44] suggestion for functions of IT utilization and its components, developed and validated a thirty items tool which measures those functions and components[43]. According to their claim for their tool's general applicability of the system-use scales across a wide range of contexts or subgroup [43 p.179], it is selected for assessing IT/IS use by users.

- User satisfaction by IS: User satisfaction is generally regarded as one of the most important measures of Information Systems success. There has been considerable research devoted to establishing a standard user satisfaction instrument since the 1980s [36,39], when data computing in organizations moved from data processing to end-user computing (EUC) [46]. Doll and Torkzadeh [46] developed and validated an End-User Computing Satisfaction (EUCS) instrument. They developed a 12-item EUCS instrument by contrasting traditional data processing environment and end-user computing environment, which comprised of 5 components: content, accuracy, format, ease of use, and timeliness. Their instrument was regarded as comprehensive, because they reviewed previous work on user satisfaction in their search for a comprehensive list of items [45] and it is reliable(reliability= 0.92)[46]. It has been used and tested by other researchers [47,48,49,50]. According to its reliability and applicability, we adopt it for measuring user satisfaction.
- IT/IS impact on individual: Relying on a review of the literature in MIS, social and economic impact of information technology, and white collar productivity, Torkzadeh and Doll[52] defined these impact dimensions as: task productivity; task innovation; customer satisfaction; and management control. The 12-item instrument had a reliability of 0.92. They also reported significant correlations between the impact measures and other theoretically related constructs such as user involvement, user satisfaction, and system usage [51 p.108]. Thus we select their instrument for assessing IT/IS impact on individual's work.

3-3 Organizational benefits/Business value perspective

Mahmood, Soon[53] during attempt for identifying organization-level and industry-level variables which potentially affected by IT, stated that organization-level variables are new entrance, entry barriers, buyer and consumers, competitive rivalry or competition, suppliers, search or switching cost, inter-organization efficiency, inter-organization efficiency and industry-level variables are markets, products and services, economics of production, and pricing. They firstly for each of 12 variables identified variables from literature and developed a comprehensive 101-item model and then tested and validated it and found a final revised model. They believe a final model with 0,93 reliability represent a good progress toward identification, measurement, operationalization and validation of strategic variables that are potentially affected by IT [53 p.880]. Mirani and Lederer[54] in similar way for identifying and operationalizing dimensions of organizational benefits of IS projects, based on Weil[55] framework, which was derived and extended from Turner and Lucas[56], known organizational objectives of IT investments as strategic, informational and transactional objectives. Strategic IT changes an organization's product or the way in which organization competes. Informational IT provides the information and communication infrastructure of the organization. Transactional IT supports operational management and cuts costs. It is possible for an IS to have objectives of all three kinds [54 p.808]. After testing and validating the initial instrument, they found a 20-item instrument in above mentioned 3 categories. Therefore based on above mentioned studies and other studies, we identified organizational variables which affected by IT:

1. Customer and consumers[53,54]
2. Suppliers[53]
3. Search or switching cost[53]
4. Inter-organization efficiency[53,54]
5. Inter-organization efficiency[53]
6. Products and services[53]
7. Economics of production[53]

8. Pricing[53]

Finally 8 above variables operationalized for measuring IT/IS organizational benefits perspective.

3-4 Internal processes/Operational perspective

Process has been defined as a "specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs"[57 p.5]. Stephen[58 p.228] in reviewing IT impact on business processes, proposed framework to understand the different roles of IT in a business process. He reported the impact of IT on business process innovation as follows:

1. Automational: IT can replace or reduce human labor in a process
2. Analytical: IT can improve analysis of information and decision making
3. Disintermediation: IT can be used to connect two parties within a process and eliminate intermediaries from a process
4. Geographical: IT can transfer and coordinate information with rapidity and ease across large distances, making processes independent of geography
5. Informational: IT can capture vast amounts of detailed process information for purpose of understanding
6. Integrative: IT can coordinate tasks and processes
7. Intellectual: IT can capture and distribute intellectual assets
8. Knowledge management: IT allows the capture and dissemination of knowledge and expertise to improve the process
9. Sequential: IT can enable changes in the sequence of tasks in a process, often allowing parallelism
10. Tracking: IT allows the detailed monitoring of process status, inputs, and outputs
11. Transactional: IT can transform unstructured processes into routinized transaction

Thus we suggest and propose that an organization firstly identify its processes and then for each process determine above mentioned impacts.

3-5 Future readiness perspective

According to the IT competitive advantage proposed by Porter and Millar [59] and IT advantage assessment model of Walter and Antonis [60] we defined measures for future readiness perspective. In their "Value Chain Model", Porter and Millar [59] have defined five steps to assess the advantages of IT. These steps are listed below:

1. Access information intensity.
2. Determine the role of IT in the industry structure and impact on five competitive forces.
3. Identify and rank the ways in which IT might create competitive advantage.
4. Investigate how IT might spawn new business.
5. Develop a plan for taking advantage of IT.

Thus we capture the first 4 steps in above as measures of future readiness perspective. Porter and Millar [59] defined several signs of high information intensity that are indicators of an industry where the use of IT can add value and based on it we developed the first measure or "Information intensity". Second measure was developed by some steps of IT advantage assessment model [60]. In this we went and we developed this perspective completely.

4-Applying framework with expert system

Due to the model scale and its many numbers of hierarchical variables, we found rule-based expert systems will be sound for it to be practical. Thus we developed an expert system,

which has all branches of model and user can make it customized for his company. Then knowledge engineer captures knowledge and rules from experts of organization and enter them into the system. After that company by using system can track its IT/IS investments on its organization. By making an IT/IS investment, operational and manager user reply to the expert system question about their perception,. Finally system based on rules and responses, determine IT/IS impact on organization on 5 defined perspective (operational perspective,..). In below a sample rule that used in system is illustrated:

- IF (Tangiles are good) AND (Reliability is good) AND (Responsiveness is poor) AND (Assurance is good) AND (Empathy is low) Then
  IT/IS service quality is Average(See the appendix)

5-Conclusion and results

In this paper, we review comprehensively IT/IS success, impact, business value in MIS field. Then we developed a model for assessing IT/IS impacts on broad aspects of an organization. Finally we apply it in expert system for practical uses. We believe that model and developed expert system can be used in organizations for tracking IT/IS investments impacts and justifying them.

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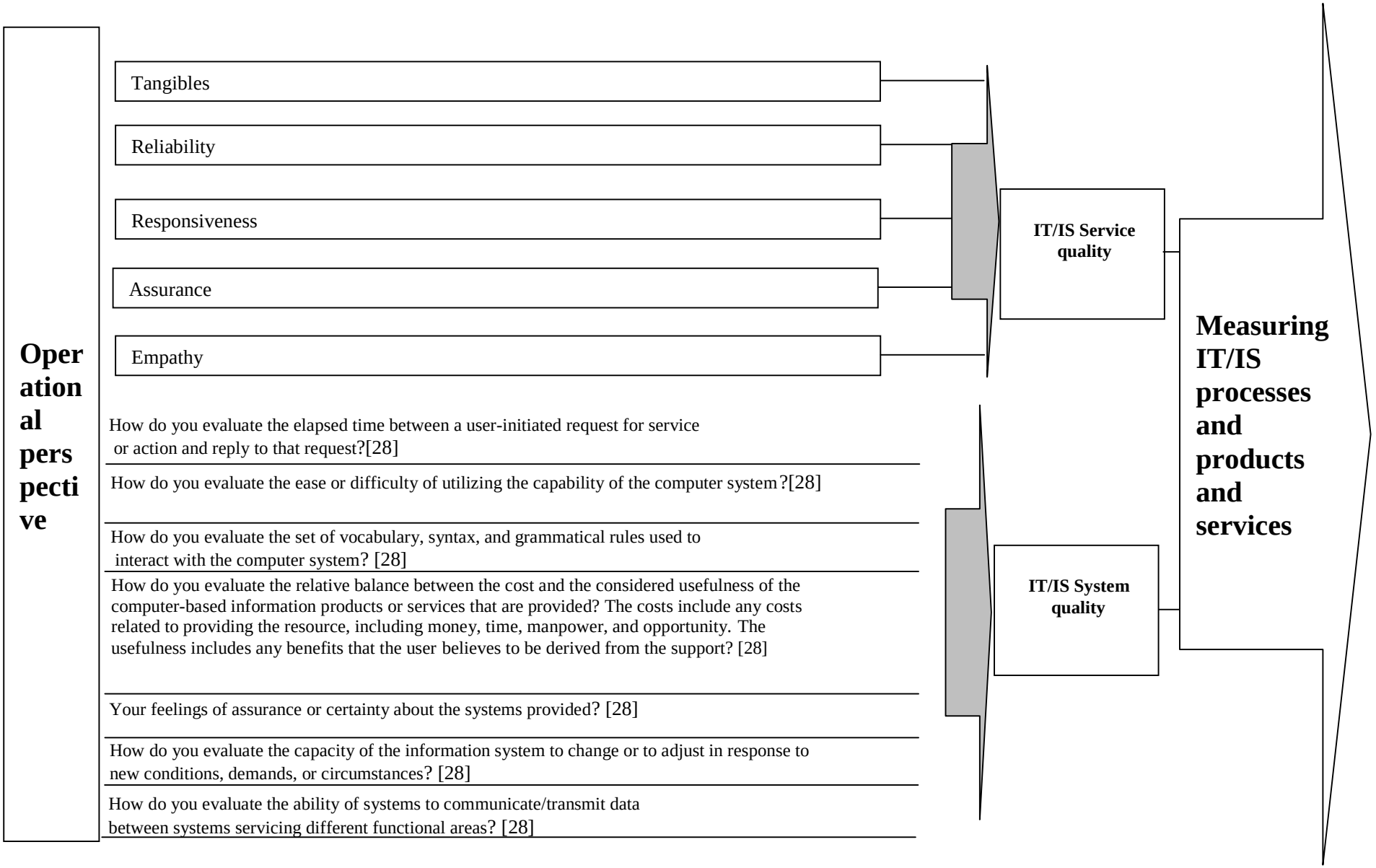
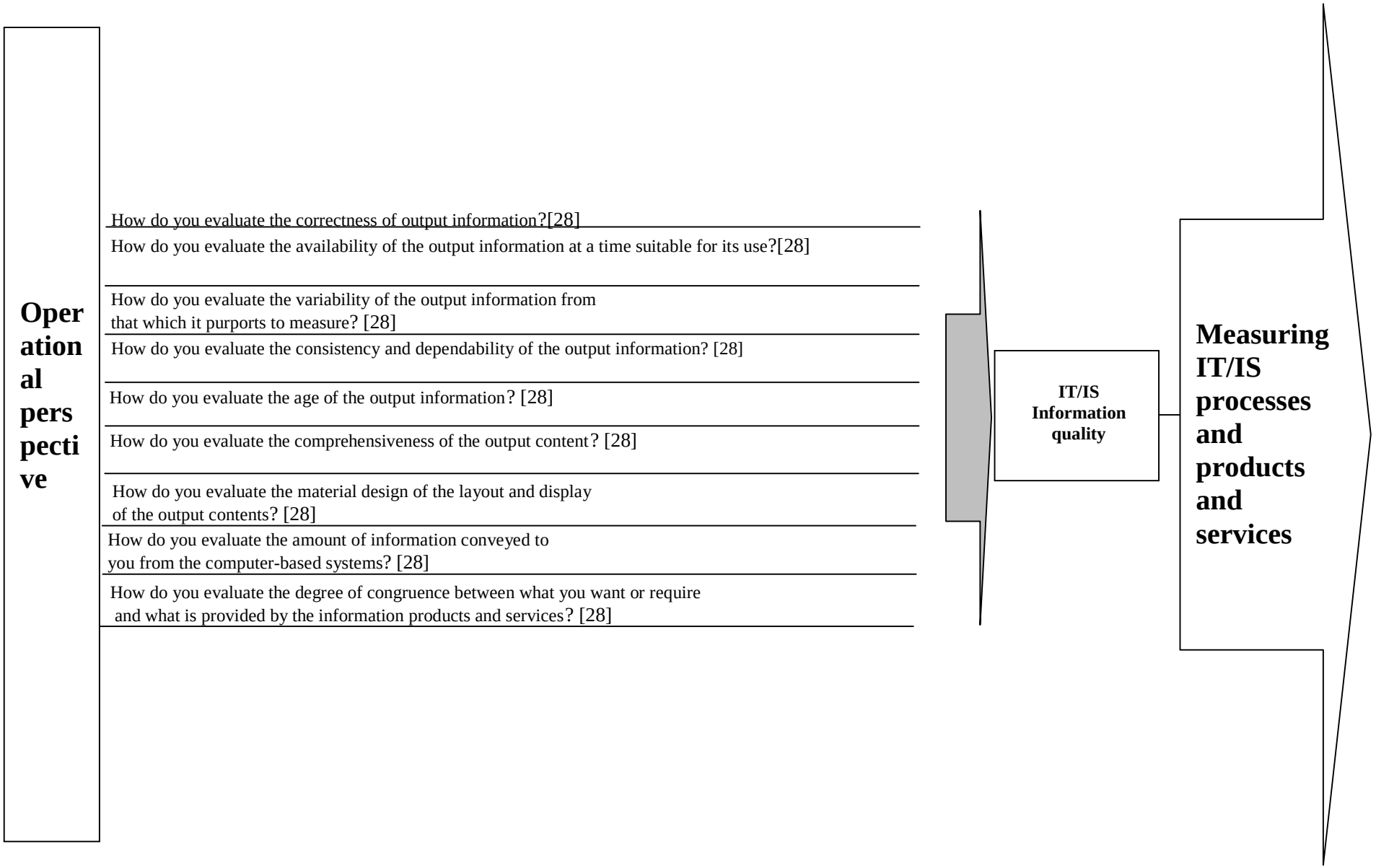
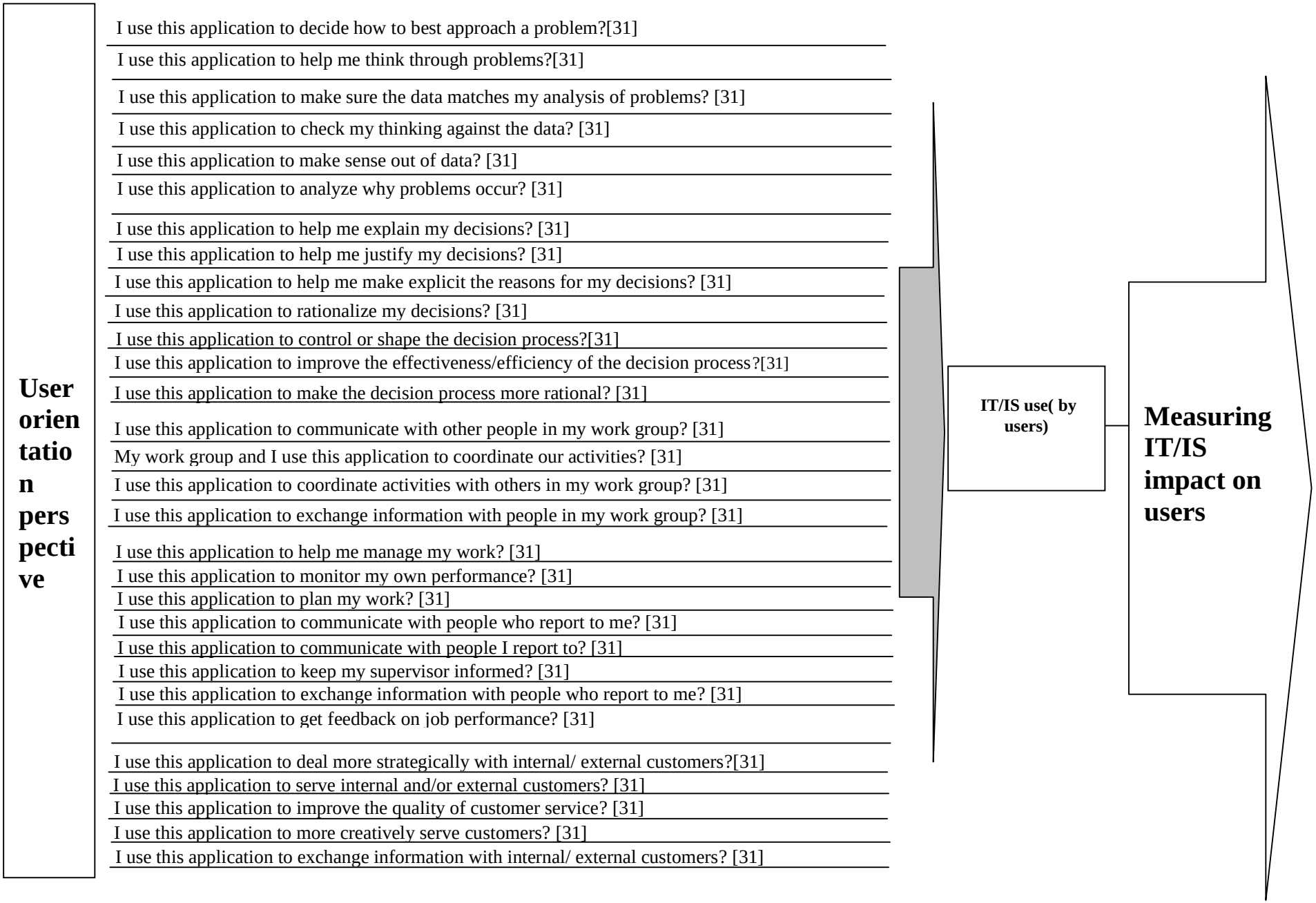
7-Appendix: Some parts of the developed Model for measuring impact of IT/IS on organization







User orientation perspective

This application saves me time? [21]
This application increases my productivity? [21]
This application allows me to accomplish more work than would be possible?[21]

This application helps me create new ideas? [21]
This application helps me come up with new ideas? [21]
This application helps me try out innovative ideas? [21]

This application improves customer service? [21]
This application improves customer satisfaction? [21]
This application helps me meet customer needs? [21]

This application helps management control the work process? [21]
This application improves management control? [21]
This application helps management control performance? [21]

Does the system provide the precise information you need? [34]
Does the information content meet your needs? [34]
Does the system provide reports that seem to be just about exactly what you need?[34]
Does the system provide sufficient information? [34]

Is the system accurate? [34]
Are you satisfied with the accuracy of the system?[34]

Do you think the output is presented in a useful format? [34]
Is the information clear?[34]

Is the system user friendly? [34]
Is the system easy to use?[34]

Do you get the information you need in time? [34]
Does the system provide up-to-date information?[34]