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Impacts of electronic process guides by types of user: An experimental study

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Abstract

The design and utilization of Electronic Process Guides (EPGs) have been studied in the Software Engineering (SwE) since the1990's. However, the empirical findings from surveys, case studies, and experiments on the beneficial effectffigures of their utilization are still lacking. Thus, we suggest that further research on the utilization of EPGs is required. In this study, we are interested in gaining insights on the effects of using EPGs on objective metrics (learning score, time effort) and subjective metrics (perceived usefulness, ease of use, and value), by comparing three EPG designs (a simple PDF-based EPG, a normal HTML-based EPG, and a sophisticated Java-based EPG) with different blocks of experimental subjects (practitioners, academicians, novices, and experts). To this end we have conducted a controlled experiment with a sample of international participants in the domain of IT Service Management. We found that the utilization of EPGs improves the objective metrics while no improvements were perceived on the subjective ones, and that the sophisticated EPG design is more appropriate for the academic and expert types of users than for the practitioner and novice types. Thus, our main recommendation for the design and utilization of EPGs is to consider the type of end-user,

Index Terms— Electronic Process Guide (EPG); CMMI-SVC; IT Service Management (ITSM), Process-oriented intensive IT areas; experimental research; repeated-measures design

1 Introduction

In the Software Engineering domain a problem faced by software engineers in learning from inherently complex documents for executing a software development process correctly has been under study from the 1990's (Kellner et al., 1998; Makela & Kunnamo, 2001; Neerincx, 2011). An element of complexity arises for the huge number of concepts (terms, phases, activities, tasks, roles, work products, techniques, tools, templates, guidelines, among others) that are employed and their interrelationships (Dougmore, 2006; Mora et al., 2010a). Thus, the utilization of software engineering process frameworks such as CMMI-DEV (SEI, 2006) and ISO/IEC 12207 (ISO, 2008) involves a complex knowledge structure, which limits their ease of implementation in organizations (Roedler, 2006). CMMI-DEV (SEI, 2006) for instance, is reported in a document of 561 pages that describes 2 representations

(continuous and staged), 5 maturity levels, 6 continuous capability levels, 22 key process areas, 5 generic goals, 17 generic practices with about 150 elaborations (specific recommendations for each one of the 22 areas for some of the 17 generic practices), 47 specific goals, 161 specific practices, and about 250 typical work products.

In this research, we are interested in addressing a similar problem found in the emergent IT Service Management (ITSM) area. ITSM is an important organizational theme in large and mid-sized organizations because its utilization has the potential to deliver more efficient and effective IT management, and ultimately better organizational value (Sallé, 2004; Johnson et al., 2007) than without an ITSM approach. From a research and academic perspective, elaboration of ITSM research and ITSM curriculum design hass been encouraged (Rai & Sambamurthy, 2006; Gallup et al., 2009). For instance, Rai & Sambamurthy (2006, p. 328) alert us on the need to integrate (idem, p. 331) IT services management frameworks (e.g., ITIL) into curricula and research. In turn, Gallup et al. assert that ITSM is an emerging discipline (2009, p. 127), which requires conceptual and empirical research.

However, ITSM practitioners and academicians interested in implementing and teaching ITSM process frameworks are faced with the challenge to learn and consult inherently complex documents similar to those found in the software engineering area (Mora et al., 2010b, 2011). Thus, given that successful ITSM implementations require adequate training and staff awareness (Pollard & Cater-Steel, 2009), among other critical success factors, we believe that ITSM professionals and academicians can benefit from process guidance support on the selected ITSM process, similar software engineering and other areas.

This process guidance support has been provided in the software engineering area through Electronic Process Guides (EPGs) (Kellner et al., 1998; Makela & Kunnamo, 2001; Neerincx, 2011). EPGs are digital documents, which are designed to support the understanding, training and execution of a particular set of processes. EPGs are not intended for enacting an organizational process (like a business process management system) but rather for supporting their correct execution by human participants (Kellner et al., 1998).

Consequently, given that the ITSM area suffers from similar problematic issues as in the Software and Systems Engineering areas, in this paper we are interested in gaining insights into the effects of use of EPGs by different types of users in the application domain of ITSM utilizing objective and subjective metrics for data collection. Thus, we have conducted a controlled experiment with a sample of 38 international practitioners and academicians in the domain of ITSM utilizing both objective (learning score, time effort) and subjective metrics (perceived usefulness, ease of use, and value) by comparing two enhanced EPG designs (HTML-based EPG, and Java-based EPG) with a PDF-based EPG, between four types of users (practitioners, academicians, novices, and experts). In summary, we found that the utilization of EPGs resulted in improvements for the objective metrics despite the lack of differences for the subjective ones for all experimental subjects, and that the sophisticated Java-based EPG design is more appropriate for the academicians and experts types of users.

The remainder of the paper continues as follows: in section 2, a review of the foundations of ITSM process models and EPGs are reported; in section 3, the formulation of this research is described; in section 4, the insights of this experimental research are reported; in section 5, a discussion of findings and implications for ITSM theory and practice are presented. Finally, this paper provides conclusions, limitations, and recommendations for further research.

2 On IT Service Management and EPGs Foundations

2.1 IT Service Management

An IT service is a more complex entity than a software system or an information system. An IT service involves the interactions of several human and technology components (hardware, software, DBMS, networks, data, applications, environment, and internal and external teams) (Mora et. al, 2015). Consequently, a software system or an information system is a critical part of an IT service (Uebernickel, 2006; Mora et al., 2014). An IT service can be defined as a service provided to one or more customers by an IT service provider, based on the use of IT and supports the customer's business processes, and is made up from a combination of people, processes, and technology as defined in a Service Level Agreement (OGC, 2007).

IT Service Management (ITSM) process models (and standards) are conceptual process frameworks which report the best managerial and engineering practices for delivering high quality IT services. In general, IT Service Management (ITSM) can be defined as a management system of organizational resources and capabilities for providing value to organizational customers through IT services (van Bon, 2007). Several ITSM process models have been reported: ISO/IEC 20000 (ISO, 2005; 2010); ITIL v2 (van Bon et al., 2005); ITIL v3 (Cartlidge, 2007; van Von et al., 2007); CobIT 4.0 (ITGI, 2005); CMMI-SVC (SEI, 2010); ITUP® (EMA, 2006; Ganek & Kloeckner, 2007; IBM, 2010); and MOF® 4.0 (Microsoft, 2008). From these ITSM process models, in particular the CMMI-SVC is unique in its free-access, and in this research is the ITSM, which is studied.

The purpose of the CMMI-SVC ITSM process model is to provide guidance for applying CMMI best practices in a service provider organization (SEI, 2010, p.3). CMMI-SVC integrates best practices from several previous ITSM process frameworks and the CMMI models developed for the software and systems engineering disciplines. CMMI-SVC is organized into four process categories: Support (SUP), Process Management (PRM), Project Management (PM), and Service Establishment and Delivery (SED). It includes 24 process areas where 7 are focused on service process areas (capacity and availability management, service continuity, service delivery, incident resolution and prevention, service transition, service system development, and strategic service management).

The other published ITSM process models share similar structures with categories of processes, process descriptions with goals, activities, tasks, procedures, roles and artifacts. Hence, all of the ITSM process models can be considered inherent complex documents to be learnt and correctly applied.

2.2 Electronic Process Guides

According to Kellner et al. (1998, p.11) a Process Guide (EPG) is "*a reference document for an intended process, providing guidance to process participants in carrying it out*" (p. 11), and its core function is "*to facilitate process understanding*" (idem, 1998; p. 12). An EPG is a process guide released in electronic format. Thus, an EPG can be defined as an: electronic document with graphical and textual representations of a process model, which enable multiple views of such processes (Koolmanojwong et al., 2008).

EPGs have been posited for overcoming the natural limitations of printed documents or their digital versions (without a specific EPG design), which are: deficient in form and content, difficult to understand, to use and to access, and scarcely used in practice (Kellner et al., 1998; Hauck et al., 2008; Leuser et al., 2009). Research findings on EPGs has found benefits of their utilization such as: training and process execution improvement

(Kellner et al., 1998); gradual tailoring of process, reuse, process conformance, resulting in better process management (Becker-Kornstaedt, 2000); and process communication improvement (Koolmanojwong et al., 2008). In contrast, the paper-based process guides have several limitations: absence of updated critical process information (Kellner et al., 1998); a linear-based organization (Becker-Kornstaedt, 2000); omission of process hierarchical-based views (Koolmanojwong et al., 2008); poor navigation capability (Kellner et al., 1998); version control and update problems (Becker-Kornstaedt, 2000); and poor utilization of diagrams and guidance charts (Koolmanojwong et al., 2008). In particular Dingsøyr et al., (2004) visualize the traditional printed process guides with such negative effects as few consulted, difficult reading, and as just "dust collectors".

However, EPGs have also some limitations: the development of EPGs for small and mid-sized organizations may not affordable given their complex design and high development costs (Kellner et al., 1998); EPGs can be wrongly designed and become isolated documents not linked with relevant current process information (Becker-Kornstaedt, 2000); and EPGs can lack of user-expected process support tools (Koolmanojwong et al., 2008).

Nevertheless, it has been also reported that EPGs may be developed from a simple design and gradually evolve to avoid an "overdone" and badly designed EPG (Dingsøyr et al., 2004), with the result of successful use. General EPGs design recommendations are (Kellner et al., 1998): (i) minimal content structure, (ii) inclusion of all core process information, (iii) a flexible page navigation for users, (iv) ease of use, (v) standard format of pages, (vi) and minimal effect of windows juggling. In the Healthcare domain, EPGs (known as computerized Clinical Practice Guidelines) are reported as support tools with regular and successful utilization (Makela & Kunnamo, 2001; Lyng, 2013; Peleg, 2013; Barr et al., 2013). Similarly EPGs have started to be used in the Systems Engineering domain (Neerincx, 2011; Kawinfruangfukul et al., 2013).

An EPG usually contains (Kellner et al., 1998; Becker-Kornstaedt, 2000) the following sections: overview, phases, activities, tasks, roles, work products, and additional resources (i.e. list of terms, tasks guidelines, templates, examples, whitepapers and tools). An overview is a concise textual description of the process guidance. Phases refer to texts and diagrams which describe the integrated view of the process from an overall organization. Activities refer to the workflow of tasks, inputs, outputs, control metrics, and tools and roles participating in them. Tasks describe the specific steps realized in each workflow. Roles describe the types of human agents in the process. Work products describe the required and generated artifacts, which are created into the process. Finally, additional resources describe complementary material.

Similarly, from a comprehensive review of the literature, we can report the following functional properties: to present an organized scheme of the knowledge chunks; to use a similar user interface in all digital pages; to provide user navigation flexibility; to present information in an adequate language; and to provide complementary tools..

2.3 Experimental Studies on the Utilization of EPGs

The utilization of EPGs has been studied with survey, case study and experimental approaches. A common research goal in all of these studies has been the identification of beneficial impacts of the utilization of EPGs. However, the findings of some studies have been contradictory or some of the expected benefits have not been found.

The Table 1 summarizes the main studies on EPGs consulted in establishing the theoretical background for this research. Table 1 reports the study, the domain area, the type of research approach, the research setting, and main

finding. In particular, we are interested in the experimental studies (Lott, 1997; McDonald and Miller, 1998; Koolmanojwong et al. 2008; Leuser 2009).

Table 1. Summary of Main EPGs Studies

Study	Domain	Type of Research Design	Evaluation Setting	Benefits by the Utilization of EPGs
Lott (1997)	**Software Engineering**	**Experiment**	**20 PhD and MSc candidates at a German University.**	**Partially.**
McDonald & Miller (1998)	**Software Engineering**	**Experiment**	**43 undergraduate students in a British University.**	**No.**
Becker-Kornstaedt et al. (1999)	Software Engineering	Multi-Case Study	Three medium-sized companies in the domains of telecommunications and space (200 developers).	Yes.
Becker-Kornstaedt and Verlage (1999)	Software Engineering	Case Study	Internal evaluation (Fraunhofer Institute for Experimental Software Engineering, Germany).	Yes.
Mannio (2001)	Software Engineering	Case Study	A Finnish telecom large company.	Yes.
Scott et al. (2002a)	Software Engineering	Case Study	A small-sized software development company (20 developers).	Yes.
Scott et al. (2002b)	Software Engineering	Survey	A small-sized software development company (12 developers).	Yes.
Dyba et al. (2004)	Software Engineering	Survey	97 developers at a Norway medium-sized software development company.	Partially.
von Wangenheim et al. (2006)	Software Engineering	Multi-Case Study	Two small Brazilian software development companies (22 and 10 employees).	Yes.
Phongpaibul et al. (2007)	Software Engineering	Case Study	3 SwE PhD students.	Yes.
Shin et al. (2007)	Software Engineering	Case Study	Internal evaluation (Information and Communications U. Korea).	Yes.
Koolmanojwong et al. (2008)	**Software Engineering**	**Experiment**	**Two groups of SwE graduate students (advanced and beginners) at a USA University.**	**Partially.**
Hauck et al. (2008)	Software Engineering	Case Study	Internal evaluation (a Brazilian University), and a small Brazilian software development company.	Yes.
Dingsøyr & Moe (2008)	Software Engineering	Case Study	31 people in a Norway medium-sized software development company.	Partially.
Leuser et al. (2009)	**Software Engineering**	**Experiment**	**6 groups of undergraduate software students in a German University.**	**Partially.**
Leppäniemi & Mäkinen (2010)	Systems Engineering	Case Study	A Finnish Agency for Disaster and Emergency Management.	Yes.
Pino et al. (2010)	Software Engineering	Multi-Case Study	2 small Spanish software development companies (with 7 and 21 people).	Yes.
Neerincx (2011)	Systems Engineering	Multi-Case Study	45 students of physics and chemistry; and 10 real participants involved in spatial missions.	Partially.
Kawinfruangfukul et al. (2013)	Systems Engineering	Survey	54 graduate students in a MSc program at a USA University.	Yes.
Barr et al. (2013)	Healthcare	Field study	18 physicians at the Hospital.	Yes.
Mohagheghi et al. (2013)	Software Engineering	Multi-Case Study	4 small-sized software development companies in Norway.	Partially.

In Lott (1997) a repeated-measures experimental design with 20 individuals is reported in the context of Software Engineering process guidance. The following main hypotheses were tested: individuals accomplish their work more efficiently when using on-line process guidance as compared to off-line guidance; individuals are willing to use an on-line system for guidance, and subjects comprehend on-line versions of process guidance better than they comprehend conventional, off-line guidance (idem, 1977, p. 269, 272). Author suggested that on-line process guidances (e.g. EPGs) can provide the following general benefits: process consistency-correctness checks by access to the same process version; process model complexity reduction through sophisticated support visualization techniques; process understanding improvement through learning activities on the EPG; and reduction of time effort. In summary, Lott found that an EPG provides process document access improvement. Main treatments studied were paper-based and online-based process guidances. Unexpected results include the following: overall, all subjects (PhD and MSc candidates) operated more efficiently with paper-based guidance than with the on-line. However, PhD candidates showed more efficient behavior with online guidance. Overall intention of use of online guidance was not confirmed but when viewed by degree level, it was supported. No differences were found on better comprehension by online-based guidances. The main implication is that the user's experience level and personal work style can affect the expected effects of using online guidance (e.g. EPGs).

McDonald and Miller (1998) conducted a repeated-measures experimental design with 43 software engineering undergraduate students. They tested the null hypothesis of no significant difference in performance between individuals performing tool-based inspection and those performing paper-based inspection, measured by the total number of defects found during a given time period (idem, 1998; p. 236). The authors also report that tool-based guidance (for software process inspection in this case) is expected to provide the following benefits: process consistency-correctness checks by the using the most updated version of the process; process document access improvement by search and more sophisticated support capabilities; and time efficiency. Overall, the null hypothesis could not be rejected.

In Koolmanojwong et al., (2008) a similar experimental study was conducted. Elaborating an EPG of the incremental Commitment Model (ICM), their approach compared EPF and Little-JIL EPG generators. The four Humphrey and Kellner's (1989) process-modeling criteria were used. These are: enable process communication, facilitate process reuse, support process evolution, and facilitate process management. Overall, both EPG generators produced EPGs with satisfactory assessment for the first three criteria. Both are considered with limited support for the fourth criteria. An exploratory usability test was also conducted with two groups of graduate students in software engineering (one with advanced students and other with beginners). Advanced group of graduate students preferred the EPF EPG by a greater level of information provided (activities, tasks, roles, work products, templates, examples, and additional links to information), while that the group of beginners graduate preferred the Little-JIL EPG by simplicity and ease of use. Main limitations reported in this study were: excessive additional information is provided by EPF EPG caused page navigation problems, and lacks of interrelationships in core concepts in Little-JIL EFP caused confusion in some activities and tasks.

Finally, in Leuser et al. (2009) an experimental study contrasting the utilization of an EPG for Requirements Engineering versus paper-based documents was conduced with 6 groups of undergraduate software engineering

students. Two initial metrics collected were: process understandability and correctness of guidance. Both were rated with a median score of 3.0 in a 5-point Likert scale. Additional collected metrics were: quality of specifications, specification effort, and implementation quality. It was found only differences in the quality of specifications in favor of the EPG utilization.

In contrast, other previous and posterior EPGs studies with survey and case study research approaches have reported benefits or partial ones. Thus, hence, the extant knowledge on the realization of benefits by using EPGs presents still gaps.

3 Research Formulation

3.1 Research Goal and Hypotheses

Based on the literature review on EPGs, which shows a lack (only 4 of the 21 studies reviewed) of experimental studies (Lott, 1997; McDonald & Miller, 1998; Koolmanojwong et al., 2008; Leuser et al., 2009) reported partial or no confirmations of the expected theoretical beneficial impacts, we peropose to address this knowledge gap.

Here we pursue the general goal to identify the positive impacts (improvements) on objective (learning score, and time effort) and subjective (perceived usefulness, ease of use, and value) metrics, by comparing two enhanced EPG designs (HTML-based EPG, and Java-based EPG) regarding a base PDF-based EPG, with different types of users (practitioner, academician, novice and expert). The Table 2 reports the general research hypotheses.

Table 2. General Research Hypotheses

H.1	***Some types of EPGs (PDF-based, HTML-based or Java-based) are perceived as useful, ease of use, and with value by some types of users (practitioners, academicians, novices or experts).***
H.2	***Some objective metrics (Learning score and Time effort) and subjective metrics (perceived usefulness, perceived ease of use, and perceived value) are improved by using an enhanced EPG design (HTML-based) or a sophisticated EPG design (Java-based) regarding a simple EPG design (PDF-based), by some types of users (practitioners, academicians, novices or experts).***

3.2 Research Design

This study uses a repeated-measures experimental design (also known as within-subjects design). In this experimental design all of the treatments are applied to all of the participants but in a randomized order (counterbalancing approach) to avoid a sequence effect (Ross & Morrison, 1996; Kirk, 1982). Thus, each participant can be considered as his/her own control when a baseline treatment is defined. This problematic of using a control group (with no stimulus managed) in Software Engineering area is eliminated (Kitchenham et al., 1994). It is also known that the repeated-measures design provides a better statistic power than a between-subjects design, is suitable for small samples, and eliminates the systematic (non-sampling) error by the application of all of the treatments to all participants (Ross & Morrison, 1996; Kirk, 1982). A similar experimental research design was used in two previous EPGs studies (Lott, 1997; McDonald & Miller, 1998)

A Wilcoxon matched-pairs signed-rank test is used for analyzing the experimental collected data (Sheskin, 2000; Wohlin et al. 2003). This statistical nonparametric test was selected because the repeated measures design implies dependent sample data, and for taking advantages of the minimal data conditions for its utilization (e.g. no required

assumption of normality in the data distribution; no required assumption of homogeneity of variance; and suitable for both small and large samples) (Sheskin, 2000).

The independent variable (e.g. treatments) considered in this investigation was the type of EPG with three levels: a PDF-based EPG (used as base), a HTML-based EPG, and a Java-based EPG. The dependent objective variables were: learning score (measured through a test score), and time effort (measured by spent time in answering the test). The dependent subjective variables were: perceived usefulness, perceived ease of use, and perceived value.

The Table 3 reports the characteristics of the independent and dependent variables. The full questionnaires for measuring the subjective dependent metrics are reported in the Appendix A.

Table 3. Independent and Dependent Variables

Variable	Definition	Scale
Type of EPG (Independent)	Electronic process guide (unique experimental factor with three levels or treatments).	{PDF-based EPG, normal HTML-based EPG, sophisticated Java-based EPG}
Learning score (Dependent)	Extent of correct knowledge learned on CMMI-SVC process model.	{ 1 .. 5 } from 1 (minimal value) to 5 (highest value).
Time Effort (Dependent)	Time interval spent for answering the applied 5-question test on CMMI-SVC process model.	{ 1 .. 100 }minutes
Perceived usefulness (Dependent)	"*the degree to which using the IT innovation is perceived as being better than using the practice it supersedes*" (Moore & Benbasat, 1991)	5-point Likert from 1 (high disagreement) to 5 (high agreement).
Perceived ease of use (Dependent)	"*the degree to which using a particular system is free of effort*" (Davis, 1989)	5-point Likert from 1 (high disagreement) to 5 (high agreement).
Perceived compatibility (Dependent)	"*the degree to which using the IT innovation is compatible with people do*" (Karahanna et al., 1999)	5-point Likert from 1 (high disagreement) to 5 (high agreement).
Perceived value (Dependent)	*"the degree to which using the IT innovation is perceived as a value delivery entity for users by savings on money, time, and the provision of a variety of valuable resources, and by an overall value*" (adapted from Lee et al., 2001)	5-point Likert from 1 (high disagreement) to 5 (high agreement).

3.3 RESEARCH EXPERIMENTAL MATERIALS

For this research we needed to have at least both a PDF-based EPG (baseline level treatment) and a HTML-based EPG of the same ITSM process model and of free-access. From the several ITSM process models ITSM (as ISO/IEC 20000 (ISO, 2005; 2010); ITIL v2 (van Bon et al., 2005); ITIL v3 (Cartlidge, 2007; van Von et al., 2007); CobIT 4.0 (ITGI, 2005); ITUP® (EMA, 2006; Ganek & Kloeckner, 2007; IBM, 2010); MOF® 4.0 (Microsoft, 2008); and CMMI-SVC (SEI, 2010)), there were not found both free-access PDF-based and HTML-based EPGs for the first six ITSM process models, despite HTML-based MOF 3.0 and ITUP EPGs are available (Mora et al., 2010).

A normal HTML-based EPG and an additional sophisticated Java-based EPG for the CMMI-SVC process framework were already available for authors. Consequently, the CMMI-SVC process model was selected for the free availability of the full PDF-based EPG document and for being one of the main international ITSM process frameworks. Next, we report a brief description of each experimental material (the three treatments or levels of the single experimental factor EPG) .

Base Treatment PDF-based EPG. This 608-page PDF document can be considered a simple monolithic EPG. It is the official description for CMMI-SVC published by the SEI (2010). The document reports: (i) overview of the CMMI for Services; (ii) the process areas structure (types of models, types of areas, processes, generic goals,

generic practices, specific goals, specific practices, work products, notes, examples and references); (iii) the description of the staged and continuous models; (iv) the description of the generic goals and generic practices; and the (v) the specific description for each process area. Each process area is widely described with the following items: purpose, introductory notes, related process areas, specific goals and practices summary, and full description of each specific practice with sub-practices and work products. PDF documents counts with a simple keywords search capability, and the outline navigation from the table of contents. It has not cost.

Treatment 1 HTML-based EPG. This EPG was elaborated and available by research team. We use the open source EPF (Eclipse Process Framework) tool for developing it. The EPG includes a part of the full CMMI-SVC (it was controlled for the evaluations). The content of the EPG includes: (i) the overall description of the four types of process areas, (ii) the full description (purpose, description, specific goals, specific practices, roles, and work products) for the Service Establishment and Delivery process area (which includes to five process); (iii) a list of core concepts; (iv) a glossary; (v) 10 checklists; and (vi) five whitepapers (including the PDF CMMI-SVC document)). Being it a HTML document, it counts with the find, hyperlinks and active maps capabilities.

Treatment 2 Java-based EPG. This EPG was also elaborated by the research team with the open source Protégé tool. The EPG also includes a part of the full CMMI-SVC (it was controlled for the evaluations). The content of the EPG includes: (i) the overall description of the four types of process areas, (ii) the full description (purpose, description, specific goals, specific practices, roles, and work products) for the Service Project Management process area (which includes to 9 process); (iii) a list of core concepts; (iv) a glossary; (v) 10 checklists; and (vi) five whitepapers (including the PDF CMMI-SVC document)). Being it a java-based application, it counts with advanced capabilities: hyperlinks, knowledge tree navigation, simple search, query constructor, and an ontology map visualizator (all of them are free access Protégé pluggings).

The Appendix B shows three illustrative figures for each one of these treatments.

3.4 Research Participants and Tasks

The four previous experimental studies on EPGs were conducted with undergraduate (McDonald & Miller, 1998; Leuser et al., 2009) or graduate students (Lott, 1997; Koolmanojwong et al., 2008). In this study, a group of 38 participants was collected from four countries (Ireland, Mexico, India and USA). The target population was defined as: IT professionals and IT academicians located in medium or large-sized international organizations. The 38 participants were contacted through the IT graduate programs where the authors participate as Professors. None reward was assigned to participants and his/her involvement was totally voluntary. However, randomization was exercised through a random order of application of the EPGs (treatments) as it is required in the repeated-measures experimental designs. The experiment was performed asynchronously in Ireland, Mexico, USA and India academic settings to facilitate the participation of individuals from four countries with different work schedules. The experiments were managed by the author located in Mexico during a two-month period.

No training session was administrated to participants to avoid any bias or sensitization toward one particular treatment, however, a 3-page document with detailed instructions on the tasks asked to participants and the three CMMI-SVC EPGs were provided to all of the participants through authors. In brief words, to all participants was asked: (i) to read the general instructions for downloading and installing experimental materials; (ii) to assign a 2-hr

period for performing the experimental tasks; (iii) to return the questionnaires to his/her international contact (e.g. the author located in this international setting). In the 2-hr period, the specific asked tasks were the following: (i) to randomly select one EPG treatment; (ii) to navigate freely in the selected EPG by a 5-minute period for familiarization with the EPG; (iii) to open the associated mini-test with the EPG and answer the 5 questions by using only the information provided by the selected EPG and registering the spent time; (iv) to repeat the steps (ii) to (iv) with a new EPG; (v) to answer the demographic and perception questionnaire; and (vi) to return these questionnaires for email to researcher in charge. The research team designed the three mini-tests. Each 5-question test was applied in random order to each participant to avoid a sequence effect. One author with the best expertise on CMMI-SVC process model from the research team reviewed and evaluated the 114 mini-tests (38 participants by 3 mini-tests times). Another author conducted an additional review of evaluations with minimal discrepancies. For the few cases of them, a score of 0.5 points was assigned to this answer. Appendix 2 reports one of the three applied tests. This package set of experimental materials (instructions, three EPGs, and three mini-tests) is available from lead author upon request for replication studies.

3.5 Internal and External Validity Threats

The internal and external validity of any experimental research can be jeopardized for several factors. Internal validity refers to extent of the observed effects in the independent variables can be really attributed to the administered treatments (Campbell & Stanley, 1963). External validity refers to the extent of the observed effects in the independent variables in the particular experimental groups of participants and used experimental settings, will be observed in other populations or settings (Campbell & Stanley, 1963). The generalization to the population studied in the experiment is assumed as true when the external validity is satisfied.

In the literature of experimental research, there has been identified a set of typical threats for internal and external validity (Cambell & Stanley, 1963; Ross & Morrison, 1996). Table 4 summarizes the threats to internal and external validity addressed in this study.

Table 4. Internal and External Threats

Threat and Problem	Countermeasure
History (Internal). Exogenous events happen during the measurement periods for the dependent variables.	Each participant was instructed to perform the three tasks in a single session between 30 to 60 minutes without interruptions and communication with other participants.
Maturation (Internal). Physical or psychological changes occur during the experimental period.	Given the short duration of the experimental period (from 30 to 60 minutes) this threat is considered inexistent.
Testing (Internal). To be influenced by pre-tests or previous knowledge on the applied tests in the experiment.	We did not apply pre-tests and none participant was informed previously of the experimental material.
Instrumentation (Internal). Inconsistent calibration or utilization of measurement instruments.	We applied a unique instrument for measuring the perceived variables (already validated in the literature). Time effort was measured in a scale of minutes. Learning score was assessed by a single researcher by using three solution templates for the three tests, and thus a single criterion was applied.
Statistical Regression (Internal). A biased selection of participants by extreme scores on a particular criterion.	A particular score did not guide our selection of participants. It was voluntary based on the inclusion criterion.
Selection (Internal). A biased selection of participants in the experimental sample.	Our repeated-measures experimental design eliminates errors by demographic differences on participants.
Experimental Mortality (Internal). Loss of experimental participants during the experimental period.	This threat happens usually in long experimental periods (months or years). Our experimental session was very short, and thus this threat was not existent.
Interaction of Testing-Treatments (External). Effects not	We did not apply pre-tests.

wished of pre-tests on participants.	
Interaction of Selection-Treatments (External). Effects not wished by a biased application of treatments to participants.	The order of application of the three treatments was random.
Reactive experimental arrangements (External). Effects not wished by the conditions in the experimental setting.	Each experiment occurred in each country was managed with an experimental setting in similar conditions (no rewards for participation, similar time periods, and no additional instructions to the official document of instructions).

4 Experimental Results

4.1 Demographic Results

The Table 5 shows the demographic profile of this experimental sample of 38 international participants. They were contacted in four countries (Ireland, Mexico, USA, and India).

This sample was blocked by the type of main type of user's occupation (DD.1: practitioner or academician), and for the self-rate expert score on ITSM process models (DD.5: novice for a score less than or equal to 3.0 vs expert for a score greater than 3.0). For the first block based on DD.1, we had 30 practitioners and 8 academicians. For the second block based on DD.5, we had 27 novices and 11 experts.

Table 5. Demographic Data

DD.1 Country of Participant by User Type				
COUNTRY	**PRACTITIONERS**	**ACADEMICIANS**	**NOVICES**	**EXPERTS**
India	6	0	6	0
Ireland	13	2	8	7
Mexico	7	3	7	3
USA	4	3	6	1
TOTAL	**30**	**8**	**27**	**11**
DD.2 Scope of Participant's Affiliation				
SCOPE	**PRACTITIONERS**	**ACADEMICIANS**	**NOVICES**	**EXPERTS**
Worldwide	9	1	8	2
Nationwide	11	6	8	9
Regional	10	1	9	0
MODE	**Nationwide**	**Nationwide**	**Regional**	**Nationwide**
DD.3 Highest Academic Degree of Participant				
DEGREE	**PRACTITIONERS**	**ACADEMICIANS**	**NOVICES**	**EXPERTS**
PhD	4	8	7	5
MSc	10	0	6	4
BSc	16	0	14	2
MODE	**BSc**	**PhD**	**BSc**	**PhD**
DD.4 Age Range of Participant				
AGE	**PRACTITIONERS**	**ACADEMICIANS**	**NOVICES**	**EXPERTS**
< 30 yrs	24	0	18	6
30-34 yrs	4	2	4	2
>= 35 yrs	2	6	5	3
MODE	**< 30 yrs**	**>= 35 yrs**	**< 30 yrs**	**< 30 yrs**
DD.5 Self-rate Expert Score on ITSM Models				
	PRACTITIONERS	**ACADEMICIANS**	**NOVICES**	**EXPERTS**
MEAN	2.2	2.4	1.8	3.2

The additional demographic data revealed interesting differences between the practitioners and academicians blocks on D.3 highest academic degree (BSc for practitioners and PhD for academicians) and D.4 age (less than 30 years for practitioners and greater than 35 years for academicians), and similarities on the other demographic variables (DD.2 scope of participant's affiliation is nationwide, and DD.5 self-rate expert score about 2.2 – 2.4).

For the case of novices and experts blocks the main differences were found on DD.2 scope of participant's affiliation (regional for novices and nationwide for experts); DD.3 highest academic degree (BSc for novices vs PhD for experts); and the DD.5 self-rate expert score about (a mean of 1.8 for novices and 3.2 for experts).

Hence, we consider that the demographic profile of the experimental sample, blocked by the type of main user's occupation (practitioner vs academician), and by the self-rate expert score (novices vs experts) is representative for our target populations of practitioners, academicians, novices and experts.

4.2 Experimental Results

The Table 6 reports the hypotheses tests on the adequate perception on usefulness, ease of use and value for the four types of users. The significance levels for the values 0.01, 05 and 0.10 are reported with the symbols ***, ** and * respectively in all of the tables. Significant supported hypotheses indicate that the mean of the metric is greater than 3.0.

In the Tables 7 and 8, we report the statistical tests of differences on the objective metrics (learning score, time effort) among the base PDF-based EPG and the two treatments HTML-based EPG and Java-based EPG by types of users. In these Tables the labels YES, NO, and the symbol -, stands by the occurrence of an improvement, the occurrence of the opposed effect, or no changes, statistically identified through the hypotheses tests. From the results presented in the Table 7, we identify that the treatment 1 (HTML-based EPG) produced improvements in all of the four types of users regarding the learning score metric. The treatment 2 (Java-based EPG) produced improvement only in the expert block of users. In Table 8, we identify that the treatment 1 (HTML-based EPG) improved the time effort for the academicians and novices' blocks, and no changes in the other two blocks (practitioners and experts). The treatment 2 (Java-based EPG) produced improvements only in the academician's block.

The Tables 9, 10 and 11 report the hypotheses tests regarding the impacts on the subjective metrics (usefulness, ease of use, and value) between the PDF-based EPG and the two treatments (HTML-based EPG and Java-based EPG). From results reported in the Table 9, we identified that usefulness is improved only in the academician's block for both treatments 1 and 2. The block of experts did not perceived changes on usefulness in the two treatments regarding the base PDF-based EPG. The block of practitioners and novices similarly did not perceived improvements on usefulness regarding the treatment 1 (HTML-based EPG) and in contrast, they considered more useful the base PDF-based EPG than the sophisticated Java-based EPG.

In the Table 10, we identified that the block of academicians and experts are not affected on their perceptions on ease of use regarding the two treatments (HTML-based EPG and Java-based EPG). In contrast, the block of practitioners and novices are affected and they considered more difficult to use the two treatments than the base PDF-based EPG.

Finally, in the Table 11, we identified that the four types of users were not affected (no changes) on their perceptions on the value of the treatment 1 HTML-based EPG regarding the base PDF-based EPG. In contrast, with

the treatment 2 (Java-based EPG) the experts block is not affected (no changes), the blocks of practitioners and novices are affected with less perceived value, and only the academicians block had improvements on the perceived value.

Table 6. Hypotheses Tests on Objective and Subjective Metrics for Types of EPGs and Types of Users

Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 1: HTML-based EPG**		**Treatment 2: Java-based EPG**	
Usefulness	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Practitioners Block	3.98 ***	0.76	3.90 ***	0.62	3.00	0.98
Academicians Block	2.75	0.73	3.50 **	0.37	3.81 *	0.84
Novices Block	3.57 ***	0.81	3.71 ***	0.56	2.88	0.89
Experts Block	4.09 *	1.03	4.06 ***	0.64	3.86 *	0.94
Ease of Use	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Practitioners Block	4.38 ***	0.84	4.12 ***	0.74	3.12	0.93
Academicians Block	4.33 *	0.79	4.08 **	0.58	3.70 *	0.54
Novices Block	4.41 ***	0.74	4.02 ***	0.76	2.97	0.85
Experts Block	4.27 *	1.03	4.33 ***	0.49	3.90 ***	0.61
Value	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Practitioners Block	3.95 ***	0.66	3.77 ***	0.47	3.05	0.85
Academicians Block	3.12	0.86	3.62 **	0.29	4.18 **	0.56
Novices Block	3.69 ***	0.57	3.74 ***	0.46	3.13	0.96
Experts Block	4.00	1.14	3.75 ***	0.40	3.65 *	0.74

Table 7. Hypotheses Tests on Objective Metric 1 (Learning score) for Types of EPGs and Types of Users

Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 1: HTML-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Learning score	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**
Practitioners Block	2.51	0.99	3.66	1.42	16.00 ***	3.94	< 0.01	YES
Academicians Block	2.62	0.64	3.81	1.36	4.00 **	1.96	< 0.05	YES
Novices Block	2.33	0.91	3.27	1.40	28.50 ***	3.18	< 0.01	YES
Experts Block	3.04	0.75	4.72	0.64	0.00 ***	2.93	< 0.01	YES
Dependent	**Base Treatment:**		**Treatment 2:**		**Wilcoxon Test of Paired Comparisons**			**Was there an**

Variables	PDF-based EPG		Java-based EPG					Improvement?
Learning score	Mean	Std. Dev.	Mean	Std. Dev.	T	Z	p-value	Improvement?
Practitioners Block	2.51	0.99	2.68	1.67	110.50	0.83	> 0.10	-
Academicians Block	2.62	0.64	3.18	1.38	4.00	1.36	> 0.10	-
Novices Block	2.33	0.91	2.27	1.50	101.50	0.13	> 0.10	-
Experts Block	3.04	0.75	4.04	1.17	0.00 ***	2.66	< 0.01	YES

Table 8. Hypotheses Tests on Objective Metric 2 (Time effort) for Types of EPGs and Types of Users

Dependent Variables	Base Treatment: PDF-based EPG		Treatment 1: HTML-based EPG		Wilcoxon Test of Paired Comparisons			Was there an Improvement?
Time effort	Mean	Std. Dev.	Mean	Std. Dev.	T	Z	p-value	Improvement?
Practitioners Block	16.06	11.88	13.30	7.56	53.50	1.39	> 0.10	-
Academicians Block	12.50	7.07	10.62	1.76	2.00 ***	0.00	< 0.01	YES
Novices Block	14.14	10.89	11.14	4.14	13.00 *	1.77	< 0.10	YES
Experts Block	18.18	11.46	16.63	10.22	13.50	0.63	> 0.10	-
Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 2: Java-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Time effort	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**
Practitioners Block	16.06	11.88	20.53	16.52	31.00 ***	2.76	< 0.01	NO
Academicians Block	12.50	7.07	11.25	3.53	2.00 ***	0.00	< 0.01	YES
Novices Block	14.14	10.89	15.70	13.32	25.00 *	1.72	< 0.10	NO
Experts Block	18.18	11.46	25.63	17.78	4.00 *	1.69	< 0.10	NO

Table 9. Hypotheses Tests on Subjective Metric (Usefulness) for Types of EPGs and Types of Users

Dependent Variables	Base Treatment: PDF-based EPG		Treatment 1: HTML-based EPG		Wilcoxon Test of Paired Comparisons			Was there an Improvement?
Usefulness	Mean	Std. Dev.	Mean	Std. Dev.	T	Z	p-value	Improvement?
Practitioners Block	3.98	0.76	3.90	0.62	164.00	0.29	> 0.10	-
Academicians Block	2.75	0.73	3.50	0.37	4.00 **	1.96	< 0.05	YES
Novices Block	3.57	0.81	3.71	0.56	119.50	0.87	> 0.10	-
Experts Block	4.09	1.03	4.06	0.64	27.50	0.00	> 0.10	-
Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 2: Java-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Usefulness	Mean	Std. Dev.	Mean	Std. Dev.	T	Z	p-value	Improvement?
Practitioners	3.98	0.76	3.00	0.98	24.00 ***	4.18	< 0.01	NO

Block								
Academicians Block	2.75	0.73	3.81	0.84	3.50 *	1.77	< 0.10	YES
Novices Block	3.57	0.81	2.88	0.89	66.50 ***	2.94	< 0.01	NO
Experts Block	4.09	1.03	3.86	0.94	19.00	0.41	> 0.10	-

Table 10. Hypotheses Tests on Subjective Metric (Ease of Use) for Types of EPGs and Types of Users

Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 1: HTML-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Ease of use	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**
Practitioners Block	4.38	0.84	4.12	0.74	60.00 *	1.92	< 0.10	NO
Academicians Block	4.33	0.79	4.08	0.58	5.50	1.04	> 0.10	-
Novices Block	4.41	0.74	4.02	0.76	28.00 **	2.50	< 0.05	NO
Experts Block	4.27	1.03	4.33	0.49	21.00	0.17	> 0.10	-
Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 2: Java-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Ease of use	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**
Practitioners Block	4.38	0.84	3.12	0.93	21.50 ***	4.23	< 0.01	NO
Academicians Block	4.33	0.79	3.70	0.54	6.00	1.35	> 0.10	-
Novices Block	4.41	0.74	2.97	0.85	0.00 ***	4.54	< 0.01	NO
Experts Block	4.27	1.03	3.90	0.61	13.00	1.12	> 0.10	-

Table 11. Hypotheses Tests on Subjective Metric (Value) for Types of EPGs and Types of Users

Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 1: HTML-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Value	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**
Practitioners Block	3.95	0.66	3.77	0.47	110.00	1.14	> 0.10	-
Academicians Block	3.12	0.86	3.62	0.29	9.50	1.19	> 0.10	-
Novices Block	3.69	0.57	3.74	0.46	116.00	0.34	> 0.10	-
Experts Block	4.00	1.14	3.75	0.40	22.00	0.56	> 0.10	-
Dependent Variables	**Base Treatment: PDF-based EPG**		**Treatment 2: Java-based EPG**		**Wilcoxon Test of Paired Comparisons**			**Was there an Improvement?**
Value	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**T**	**Z**	**p-value**	**Improvement?**

Practitioners Block	3.95	0.66	3.05	0.85	33.50 ***	3.85	< 0.01	NO
Academicians Block	3.12	0.86	4.18	0.56	5.00 *	1.82	< 0.10	YES
Novices Block	3.69	0.57	3.13	0.96	90.00 **	2.17	< 0.05	NO
Experts Block	4.00	1.14	3.65	0.74	19.00	0.86	> 0.10	-

Table 12. Summary of Results of H.1 Hypotheses Tests

BLOCKS	**H1. THE METRIC IS CONSIDERED AS ADEQUATE (A MEAN VALUE GREATER THAN 3.0)**								
	USEFULNESS			**EASE OF USE**			**VALUE**		
	PDF EPG	**HTML EPG**	**JAVA EPG**	**PDF EPG**	**HTML EPG**	**JAVA EPG**	**PDF EPG**	**HTML EPG**	**JAVA EPG**
Practitioners	✓	✓	×	✓	✓	×	✓	✓	×
Novices	✓	✓	×	✓	✓	×	✓	✓	×
Academicians	×	✓	✓	✓	✓	✓	×	✓	✓
Experts	✓	✓	✓	✓	✓	✓	×	✓	✓

Table 13. Summary of Results of H.2 and H.3 Hypotheses Tests

BLOCKS	**H.2 AND H.3: THE OBJECTIVE AND SUBJECTIVE METRICS ARE IMPROVED WITH THE ENHANCED EPGs REGARDING THE SIMPLE PDF-BASED EPG.**									
	Learning score		**Time effort**		**Usefulness**		**Ease of use**		**Value**	
	HTML EPG	**JAVA EPG**	**HTML EPG**	**JAVA EPG**	**HTML EPG**	**JAVA EPG**	**HTML EPG**	**JAVA EPG**	**HTML EPG**	**JAVA EPG**
Practitioners	YES	-	-	NO	-	NO	NO	NO	-	NO
Novices	YES	-	YES	NO	-	NO	NO	NO	-	NO
Academicians	YES	-	YES	YES	YES	YES	-	-	-	YES
Experts	YES	YES	-	NO	-	-	-	-	-	-

4.3 Discussion of Results

The Table 12 summarizes the results of the hypotheses tests, and the Table 13 summarizes such effects. The symbols (✓,×), in Table 12, illustrates respectively that the hypothesis is supported or is not supported. In the Table 13 the notation (YES, - , NO) means respectively that the hypothesis is supported, is not supported because none statistical changes occurred, or occurred the contrary effect.

We established H.1 as follows: "*Some types of EPGs (PDF-based, HTML-based or Java-based) are perceived as useful, ease of use, and with value by some types of users (practitioners, academicians, novices or experts)*". This hypothesis H.1 is supported for practitioners and novices blocks for the PDF-based and HTML-based EPGs. Both types of users exhibit a similar behavior by perceiving as adequate the simple EPG (PDF-based) and the enhanced but not sophisticated EPG (HTML-based), and rating as not adequate the sophisticated EPG (Java-based). An interesting and contrasted situation was found for the academicians and expert's blocks. Both perceived as adequate the enhanced (HTML-based) and the sophisticated (Java-based) EPGs, and do not the simple EPG (PDF-based).

These results support the evidences on previous experimental studies (Lott, 1997; McDonald and Miller, 1998; Koolmanojwong et al., 2008) regarding the need of an adequate theoretical knowledge background in the domain of the EPG. For instance, Lott (1997) found in his experimental study that PhD students improved some performance metrics regarding MSc students. McDonald and Miller (1998) also found no improvements with an experimental sample of novices (undergraduate students). In the experimental study of Koolmanojwong et al., (2008), advanced graduate students preferred a sophisticated EPG and beginner graduate students a simple EPG. Finally, in the experimental study of Leuser et al. (2009) with samples of undergraduate students, was found only one improvement on several tested metrics.

Our hypotheses H.2 was stated as: "*Some objective metrics (Learning score and Time effort) and subjective metrics (perceived usefulness, perceived ease of use, and perceived value) are improved by using an enhanced EPG design (HTML-based) or a sophisticated EPG design (Java-based) regarding a simple EPG design (PDF-based), by some types of users (practitioners, academicians, novices or experts)*". For the practitioners and novices blocks was found that while they do not perceived a better usefulness, ease of use or value on the enhanced (HTML-based) or sophisticated (Java-based) EPG designs regarding the simple EPG (PDF-based), they do effectively improve their learning score. For the case of academicians and expert's blocks we also found that learning score was improved, but there were only improvements for specific combinations of EPG-user types. Most interesting finding is the contrast of academicians' vs experts' perceptions regarding the sophisticated EPG (Java-based). Academician's metrics are in overall improved by the sophisticated EPG design (Java-based), and experts, except on learning score, are not affected.

Despite the scarcity of experimental research on EPGs, it has been recently identified in the domain of Software Engineering (Pino et al., 2008) that the utilization of EPGs is a relevant proposal for software process improvement initiatives for small and medium size software companies. These authors (idem, 2010) found in 18 studies, from the total of 45 selected core studies, that: *Establish software processes (Use of electronic process guides and experience repository—EPG-ER)*, p. 249) is a key recommendation for software process improvement initiatives.

Under this situational research context, we consider that our empirical experimental study contributes to the literature on EPGs with particular findings on the types of EPGs and types of users help to support the found initial experimental evidences on no improvements in all type of users, rather on specific ones characterized by a higher level of theoretical knowledge in the domain of the EPG.

Our study also provides empirical evidences for supporting the general assumption on adequate perceptions on EPGs, but it has also identified that basic (practitioners and novices) and advanced (academicians and experts) users can prefer different types of EPGs (simple or normally enhanced EPGs for basic users, or normally enhanced and sophisticated EPGs for advanced users).

As a summary of scientific findings, we can indicate that: 1) basic (practitioners and novices) and advanced (academicians and experts) users perceive in overall as adequate the EPGs; 2) basic (practitioners and novices) and advanced (academicians and experts) users can be benefited by using EPGs on an objective metric of Learning score; 2) basic (practitioners and novices) users prefer simple (PDF-based) or normally enhanced (HTML-based) EPG designs; 3) advanced (academicians and experts) users prefer normally enhanced (HTML-based) or enhanced (Java-based) EPG designs; 4) academicians perceive more benefits than experts on normally enhanced (HTML-

based) or enhanced (Java-based) EPG designs; and 5) the benefits by using EPGs is dependently from the pair EPG-user type.

This study also provides valuable contributions for the practice: 1) it helps to IT service management scholarly and professional communities with the establishment of empirical insights on the potential positive impacts and requirements of utilization of EPGs which are consistent with the previous experimental studies; 2) it brings to the IT service process management research stream the need of further conceptual and empirical research on EPGs; and 3) it presents an initial evaluation model of metrics (correct learning, time effort, usefulness, ease of use, compatibility and value) for EPGs.

5 Conclusions

In this paper, we have identified that the utilization of and the research on EPGs in the domain of IT Service Management has been null, despite the availability of two relevant proprietary ITSM EPGs (one for ITUP and one for MOF 4.0), and the need of ITSM practitioners and academicians to be assisted by automated process guidance tools. However, in other domains such as Software Engineering, Healthcare and Systems Engineering, EPGs have been studied and promoted. In particular, in this research we review core literature on EPGs in the Software Engineering domain, and we unexpectedly found that several expected benefits were not found in the four previous experimental research studies. A plausible main reason is that in all these studies the participants were full-time undergraduate or graduate students, with null or minimal professional experience.

In this experimental study (a repeated-measures design), a sample of 38 international IT participants was blocked as practitioner-academician (30 vs 8 participants) and as novice-expert (27 vs 11 participants) and were exposed to three EPGs (a PDF-based EPG (control-baseline treatment), an HTML-based EPG (treatment 1), and a Java-based EPG (treatment 2). Two objective metrics (correct learning and time effort) and three subjective perceived metrics (usefulness, ease of use, and value) were measured. We found in overall findings to support the general assumption of benefits by using EPGs, but they are dependently of the specific pair combination of EPG-user type. We found statistical tested differences on perceptions from basic (practitioners and novices) to advanced (academicians and experts) users by types of EPGs.

Hence, we consider this empirical repeated-measure experimental design study contributes the advance of the research stream on the design and utilization of EPGs in the new domain of ITSM and shows the overall positive effect of the utilization of EPGs but alerts on the dependence of the type of EPG and type of user.

As any research study, this study had some methodological limitations: 1) our study collected data in an asynchronous experimental mode (in four locations managed by four researchers) and plausible differences in the voluntary motivation and willingness of participants to participate in the experiment might introduce interactions in the measured effects; 2) each participant was asked to apply the set of instructions reported in the sent material (one PDF document of instructions, three EPGs, one demographic questionnaire, three tests, and one evaluation questionnaire; 3) each participant was self-trained (none author explained the instructions to participants); 4) the overall assigned time was relatively short given that for initial navigation (first and unique time) for each EPG was assigned a period of 5 minutes and for answering the associated questionnaire was limited to other 5 minutes but in

the event of uncompleted test, additional time was allowed; 5) the demographic profile of the sample suggests that over the 70% were really neophyte with the knowledge of IT Service Management process schemes: 6),the participation was totally voluntary and none reward for it was given to them; and 7) the survey was conducted in the end of scholarly semester where more stress and pressure exists in participants (IT professionals enrolled as part-time students in IT MSc programs and IT Faculty).

We consider that through additional similar experimental designs our initial insights can be confirmed and augmented with the lately aim to provide computer-based tools for improving the learning and utilization of process in the IT Service Management domain. EPGs can be the type of required computer-based tools.

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Appendix A. Evaluation Questionnaires

1. PERCEIVED USEFULNESS

1. If I were to use this TOOL-X, it would enable to accomplish my CMMI-SVC learning tasks more quickly
2. If I were to use this TOOL-X, the quality of my work (CMMI-SVC learning) would improve
3. If I were to use this TOOL-X, it would enhance my effectiveness on the job (related with CMMI-SVC learning)
4. If I were to use this TOOL-X, it would make my job (related with CMMI-SVC learning) easier

2. PERCEIVED EASE OF USE

1. Learning to operate this TOOL-X, would be easy for me
2. If I were to use this TOOL-X, it would be easy to operate
3. If I were to use this TOOL-X, it would be difficult to use (this item is calculated in reverse).

3. PERCEIVED COMPATIBILITY

1. If I were to use this TOOL-X, it would be compatible with most aspects of my work (related with CMMI-SVC learning)
2. If I were to use this TOOL-X, it would fit my work style (related with CMMI-SVC learning)
3. If I were to use this TOOL-X, it would fit well with the way I like to work (related with CMMI-SVC learning)

4. PERCEIVED VALUE

1. The value for saving money by using this TOOL-X for CMMI-SVC learning tasks is
2. The value for saving valuable time by using this TOOL-X for CMMI-SVC learning tasks is
3. The value for be able to locate a wide variety of CMMI-SVC data, information and knowledge by using this TOOL-X is
4. In overall, the value of using this TOOL-X for CMMI-SVC learning tasks is

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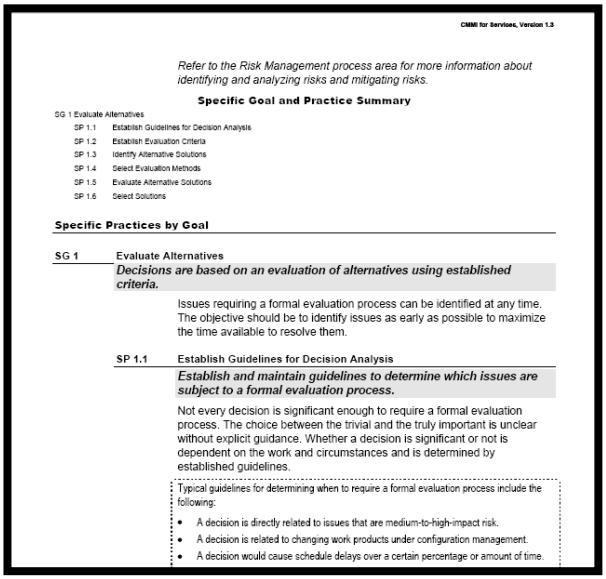
Appendix B. Illustrations of the Three EPGs



CMMI for Services, Version 1.3

Refer to the Risk Management process area for more information about identifying and analyzing risks and mitigating risks.

Specific Goal and Practice Summary

SG 1 Evaluate Alternatives
- SP 1.1 Establish Guidelines for Decision Analysis
- SP 1.2 Establish Evaluation Criteria
- SP 1.3 Identify Alternative Solutions
- SP 1.4 Select Evaluation Methods
- SP 1.5 Evaluate Alternative Solutions
- SP 1.6 Select Solutions

Specific Practices by Goal

SG 1 Evaluate Alternatives

Decisions are based on an evaluation of alternatives using established criteria.

Issues requiring a formal evaluation process can be identified at any time. The objective should be to identify issues as early as possible to maximize the time available to resolve them.

SP 1.1 Establish Guidelines for Decision Analysis

Establish and maintain guidelines to determine which issues are subject to a formal evaluation process.

Not every decision is significant enough to require a formal evaluation process. The choice between the trivial and the truly important is unclear without explicit guidance. Whether a decision is significant or not is dependent on the work and circumstances and is determined by established guidelines.

Typical guidelines for determining when to require a formal evaluation process include the following:

- A decision is directly related to issues that are medium-to-high-impact risk.
- A decision is related to changing work products under configuration management.
- A decision would cause schedule delays over a certain percentage or amount of time.

Figure 1. Illustration of the Control-Baseline Treatment: a simple PDF-based EPG

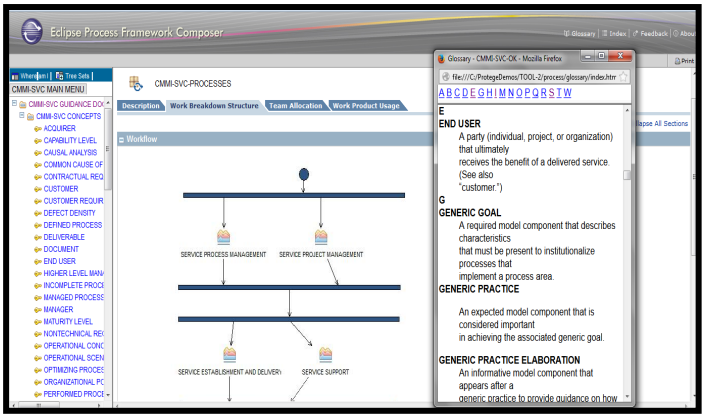


Figure 2. Illustration of the Treatment 1: a normal HTML-based EPG

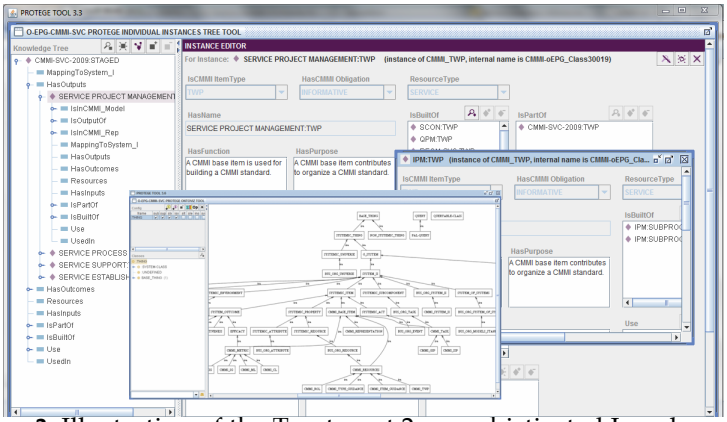


Figure 3. Illustration of the Treatment 2: a sophisticated Java-based EPG