informatics

MDPI

Review

Organizational Strategies for End-User Development—A Systematic Literature Mapping

Augusto S. C. Modesto [1], Rejane M. da C. Figueiredo [1,2], Cristiane S. Ramos [1], Letícia de S. Santos [1,2], Elaine Venson [1] and Glauco V. Pedrosa [1,2,*]

[1] Information Technology Research and Application Center (ITRAC), University of Brasilia (UnB), Brasilia, DF 72444-240, Brazil; augusto.modesto@live.com (A.S.C.M.); rejanecosta@unb.br (R.M.d.C.F.); cristianesramos@unb.br (C.S.R.); leticia.souza212@gmail.com (L.d.S.S.); elainevenson@unb.br (E.V.)

[2] Post-Graduate Program in Applied Computing, University of Brasilia (UnB), Brasilia, DF 2444-240, Brazil

* Correspondence: glauco.pedrosa@unb.br

Abstract: In the last few years, several organizations have been looking for strategies to meet the needs of users of Information Technology (IT). The decentralization of IT and the empowerment of nonprofessional users have been a viable option among these strategies. This study aimed to identify the End-User Development (EUD) strategies adopted by organizations. A systematic mapping was performed in order to provide for a structured body of knowledge and find potential research gaps. The results show that EUD methods and techniques are the most common strategies addressed in the literature. Also, most of the EUD strategies identified a focus either on EUD managerial issues, such as risk management, or on more technical elements, such as the implementation of components for EUD applications. The benefits and barriers to the adoption of EUD by organizations are also presented in this study. In general, defining EUD processes is a common gap in EUD surveys. We reinforce the need to carry out more research on the adoption of EUD in organizations, with a high level of evidence to validate the results.

Keywords: end-user development; EUD; organizational strategies; systematic literature mapping

check for updates

Citation: Modesto, A.S.C.; Figueiredo, R.M.d.C.; Ramos, C.S.; Santos, L.d.S.; Venson, E.; Pedrosa, G.V. Organizational Strategies for End-User Development: A Systematic Literature Mapping. *Informatics* **2021**, *8*, 15. https://doi.org/10.3390/informatics8010015

Received: 26 January 2021
Accepted: 23 February 2021
Published: 28 February 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

With the advancement of technology in the last few years, several organizations have been looking for Information Technology (IT) strategies to meet the needs of the business units in a timely manner [1]. On their turn, these units seek to build applications that solve daily problems [2]. End-user development (EUD) emerges as a solution that covers this issue.

EUD is defined as a set of methods, techniques and tools that allow for nonprofessional users to act at some point of the life cycle of a software, such as creating, modifying or further developing a software artifact [3]. Various EUD approaches exist [4], such as spreadsheets, natural language programming, scripting languages, visual programming and programming by example. Because of their common use in business, the spreadsheet is the most popular EUD tool, as it allows us to write complex programs while shielding the users from the need to learn lower-level programming languages. The programming by example approach infers some abstractions corresponding to a program that produces a desired result. The user performs a sequence of actions that the computer must repeat, generalizing it to be used in different data sets. New data may then be introduced to the automatically created program, and the user can correct any mistakes made by the program in order to improve its definition.

EUD has been adopted by both nonprofessional users seeking to develop software solutions for private use [5] and organizations willing to provide business areas with resources, such as professionals, processes, tools, and architecture, that help them develop

their own software [6]. However, many business representatives may have difficulty recognizing which strategies should be incorporated into their business units.

The participation of IT in the process of software development by nonprofessional IT users and the control over the applications developed are essential for the adoption of successful EUD strategies. It is important for the organization to understand how to decentralize the functions of IT to the end-users in order to prepare for the daily challenges.

Studies such as [6], which focus on the adoption of EUD by organizations, have described non-professional end-users' engagement in the modification, extension, and even creation of artifacts. The authors point that the use of EUD technology makes it easier to create applications that meet the needs of these users, as they enable them to develop applications with little knowledge of computing. These technologies may be in line with other EUD strategies.

The number of publications about EUD has been rising over recent years, as suggested by Tetteroo and Markopoulos [7] in a systematic literature review on research methods in the field of EUD. Publications about EUD date from the 1970s—for example, McLean [8]. More recent studies, such as the systematic literature review conducted by Hang et al. [9], which mapped activities and tools in the EUD context, did not focus on EUD strategies for organizations. In order to fill this gap, our study aims at answering the question, 'what are the strategies used by organizations in EUD?' To answer this question, systematic literature mapping [10] was performed considering the years 1996–2020. The main contributions of this study are:

- A systematic process to map the literature, following the guidelines provided by Petersen et al. [11], in Section 2;
- A quantitative analysis of the studies mapped, which approached the adoption of EUD strategies by organizations, in Section 3;
- A qualitative analysis of the main strategies to adopt EUD, the benefits and barriers to the adoption of EUD, and the techniques used in the studies selected to evaluate data in Section 4;
- A discussion on the relevant strategies to adopt EUD found in the literature in Section 5;
- A brief guide for future research on the adoption of EUD strategies in organizations in Section 6.

2. Mapping Study Planning

This section presents the research protocol developed for the systematic literature mapping about EUD strategies used in organizations. A systematic literature mapping provides a comprehensive view of the research area, making it possible to find research evidence on a particular subject [11]. Figure 1 shows the process for systematic literature mapping performed in this research.

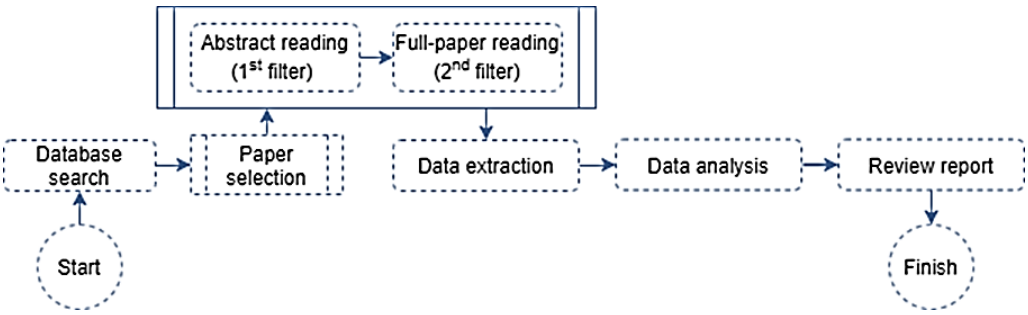


Figure 1. Steps of the systematic literature mapping.

The research protocol developed for this systematic literature mapping is briefly explained as follows.

2.1. Research Questions

This systematic literature mapping aims to identify initiatives for the adoption of EUD as an organizational strategy. Four secondary questions were phrased:

- (SQ1) What are the processes, methods, and techniques used to adopt EUD in the organizational context?
- (SQ2) What are the benefits of the adoption of EUD in the organizational context?
- (SQ3) What are the barriers to the adoption of EUD in the organizational context?
- (SQ4) How does one assess the outcomes of the adoption of EUD in the organizational context?

2.2. Scope of the Research

Based on the secondary research questions, a search string was developed using the PICOC approach [12]—Population, Intervention, Comparison, Outcomes, and Context—as presented in Table 1.

Table 1. The Population, Intervention, Comparison, Outcomes, and Context (PICOC) approach.

	Term	Synonyms
P Population	End-user development	EUD; End-user programming; EUP; End-user computing; EUC; End-user software engineering; EUSE
I Intervention	Strategy	Initiative; management; approach; framework; model
C Comparison	–	–
O Outcome	Process; Method; Technique; Motivation; Barrier; Difficulty; Benefit	–
C Context	Organization	Government; industry; company; enterprise

Based on these terms, the search string was generated—TITLE-ABS-KEY ((“end-user Development” OR eud OR “end-user programming” OR eup OR “end-user computing” OR euc OR “end-user software engineering” OR euse) AND (strategy OR initiative OR management OR approach OR framework OR model) AND (process OR method OR technic OR motivation OR barrier OR difficulty OR enabler OR benefit) AND (organization OR government OR industry OR company OR enterprise)) AND (PUBYEAR > 1995).

The search was conducted in the SCOPUS database, which indexes more than 22 thousand titles, including the main databases in the area of computing; for example, IEEE Xplore Digital Library, Springer Link, and ACM Digital Library. Also, the search string limits results to studies published since 1995; therefore, the strategies adopted in the last two decades were found.

It is important to mention that this search did not distinguish between the terms EUC (end-user computing), EUSE (end-user software engineering), EUP (end-user programming), and EU (end-user). The review included publications on any of these topics, thus adopting the perspective taken by the authors of each paper and generalizing the approaches to define EUD as in Lieberman [3].

2.3. Selection of the Relevant Papers

The following inclusion (IC) and exclusion (EC) criteria were used for the selection of the relevant papers:

- IC1—The study discusses approaches to EUD in organizations.
- IC2—The study proposes or reports the use of processes, methods, or techniques that support the implementation of EUD in organizations.
- IC3—The study proposes or reports factors that motivate the adoption of EUD in organizations.
- IC4—The study proposes or reports barriers or enablers for EUD in organizations.

- IC5—The study proposes or reports the benefits obtained (or expected) from the adoption of EUD in organizations.
- IC6—The study proposes or reports how the results obtained (or expected) from the adoption of EUD in organizations are assessed.
- IC7—The study proposes or reports the risks and limitations associated with the adoption of EUD in the organizations.
- EC1—The study is not written in English.
- EC2—The study is not available for reading.
- EC3—The study is a conference review.
- EC4—The study does not answer at least one of the secondary questions.

Figure 2 shows the process of paper selection. The search string retrieved 232 publications. After title and abstract reading, the papers were selected according to IC1 and EC2. After the first filter, 74 papers were kept, which represented 32% of the initial set.

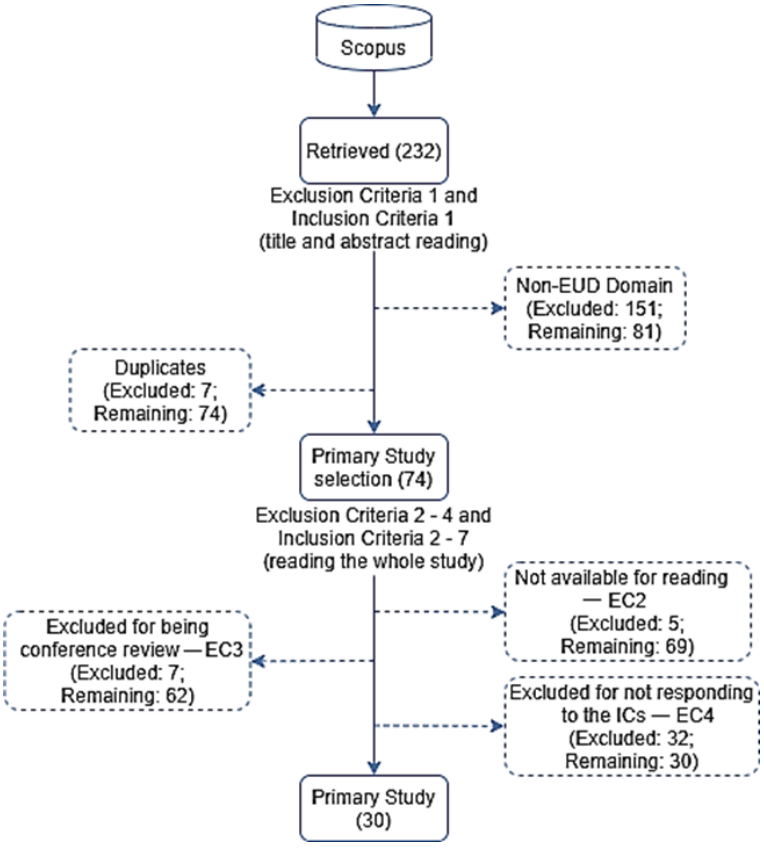


Figure 2. Process of paper selection.

A total of 151 studies were rejected (65%) because most of them belong to other areas of knowledge, though having similar acronyms, such as EUP (Energy-Using Product and Early Upper Paleolithic), in Chemistry or Extended Unified Process, from Unified Process (UP), in Computation; EUC (European Universities Championship), a handball organization; EUD (Equivalent Uniform Dose), in Medicine, and Energy Utilisation Diagrams, in Energy; and EUS (End User Satisfaction), which approaches end-user satisfaction, but not necessarily the user-developer. Besides, some rejected articles concerning EUD were not related to the objective of this study, that is, they did not follow IC1. The 7 remaining papers (3%) were duplicates.

The other inclusion and exclusion criteria were applied to the 74 studies selected for full-paper reading (Filter 2). Among the studies rejected, five articles (7%) were not available for download (EC2); seven (10%) were conference review abstracts (EC3); and 32 (43%) did not answer at least one of the secondary questions (EC4).

Table 2. List of papers selected.

Code	Ref.	Code	Ref.	Code	Ref.	Code	Ref.	Code	Ref.
S01	[13]	S07	[14]	S13	[15]	S19	[16]	S25	[17]
S02	[18]	S08	[19]	S14	[20]	S20	[21]	S26	[22]
S03	[23]	S09	[24]	S15	[25]	S21	[26]	S27	[27]
S04	[28]	S10	[29]	S16	[30]	S22	[31]	S28	[32]
S05	[33]	S11	[34]	S17	[35]	S23	[36]	S29	[37]
S06	[38]	S12	[39]	S18	[40]	S24	[41]	S30	[42]

After the application of the inclusion and exclusion criteria, the 30 studies (40%) listed in Table 2 were selected.

3. Mapping Study—Quantitative Analysis

This section presents the consolidation of the data extracted in this systematic literature mapping.

3.1. Classification of the Studies by Bibliometric Data

3.1.1. By Year of Publication

The studies were published between 1996 and 2020 (24-year period). Few studies have been published on the adoption of EUD strategies in organizations, as shown in Figure 3. In general, there are one or two publications per year, with the exception of 2009, when there were five publications and 2013, with three publications. The moving average of the previous two periods, represented by the dashed line, shows a tendency of less than one publication in the following years. There is a small number of studies about EUD in this context.

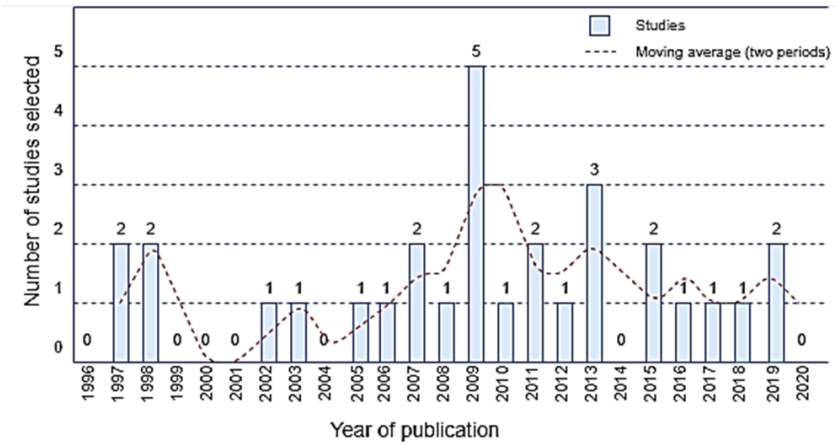


Figure 3. Number of studies published per year.

3.1.2. By Type of Publication

Most of the publications selected are journal articles, corresponding to 60% (18 studies). Conference papers correspond to 33% (10 studies). Last, book chapters are 7% (2 studies) of the publications selected.

3.1.3. By Author

The authors who have published the most on EUD strategies adopted in organizations are Buddhima De Silva (De Silva B.) and Athula Ginige (Ginige A.) with studies [S07], [S09], [S12] and [S16]; Hege-René Hansen Åsand (Åsand H.-R.H.) and Anders MØrch (MØrch A.) with studies [S08] and [S10]; Daniela Fogli (Fogli D.) with studies [S13] and [S17]; Volker

Wulf (Wulf V.) with studies [S14] and [S19]; Michael Spahn (Spahn M.) with studies [S11] and [S14]; and Trevor Wood-Harper (Wood-Harper A. T.) with studies [S03] and [S05]. The remaining authors published at least one of the studies selected in this review.

3.1.4. By Country

The countries with more publications are: Australia with six studies ([S05], [S06], [S07], [S09], [S12] and [S16]); United States with four studies ([S02], [S19], [S22] and [S30]); Germany with three studies ([S11], [S14] and [S19]); Spain ([S20] and [S24]), Norway ([S08] and [S10]), Canada ([S04], [S25]), Sweden ([S23] and [S27]), Italy ([S13] and [S17]), and United Kingdom ([S03] and [S05]) with two studies each; and Switzerland ([S15]), Taiwan ([S01]), Denmark ([S27]), Brazil ([S26]), Austria ([S18]), New Zealand ([S18]), China ([S21]), Slovenia ([S29]) and The Netherlands ([S28]) with one study each.

Also, among the 27 studies, four publications resulted from the cooperation between countries: study [S05] from ISRC, Information Systems Institute, University of Salford (United Kingdom) and University of South Australia (Australia); study [S18], represented by the School of Management, University of Innsbruck (Austria), and ACIS Department, University of Canterbury (New Zealand); study [S19] by the HCI Institute, Carnegie Mellon University (United States), and the Department of Information Systems, University of Siegen (Germany); and study [S27], represented by IT University (Denmark) and World Maritime University and Malmö University Sweden (Sweden).

3.2. Classification of the Studies by Research Approach

3.2.1. By Research Approach/Year

The studies were classified according to the research approaches adapted by Petersen and Feldt [11] and Wieringa et al. [43], which were originally proposed for the field of education in order to record the type of research reported in the primary studies selected—evaluation research; validation research; proposal of solution; experience paper; philosophical paper; and opinion paper. Figure 4 shows that the studies published from 1996 to 2001 were mostly proposals of solution and evaluation research—they presented, respectively, the solution to a given problem based on existing techniques (or the extension of them) and the practical implementation of some techniques, as well as their benefits and disadvantages.

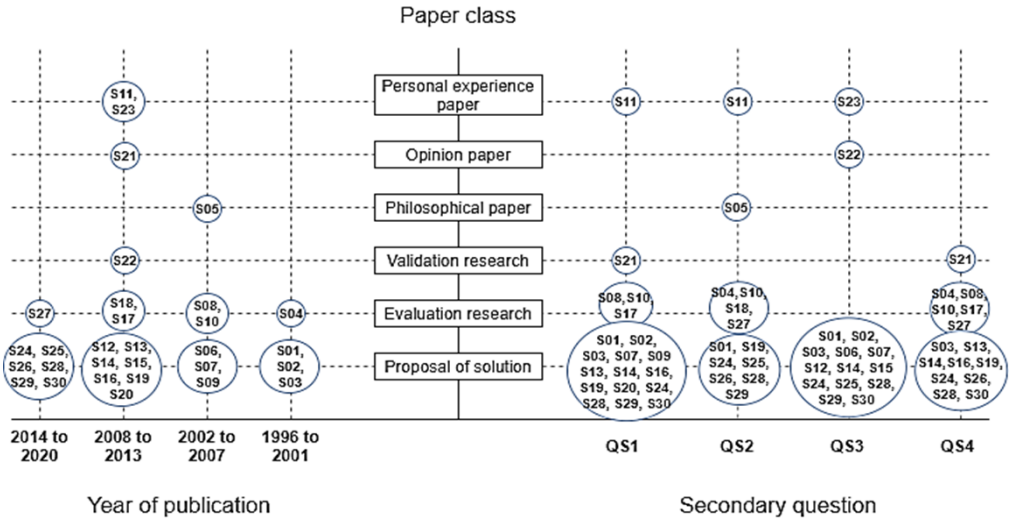


Figure 4. Research approaches.

From 2002 to 2007, three proposals of solution, two evaluation studies and one philosophical paper were published. Philosophical papers outline a new way of looking at something, elaborating on the domain of knowledge as a taxonomy or a conceptual frame-

work [43]. From 2008 to 2013, 13 studies were published—seven proposals of solution, two evaluation studies, one validation study, one opinion paper and two experience reports.

According to [43], validation research investigates new techniques that have not yet been implemented. Opinion papers express the author's personal standpoint on whether a particular technique is good or bad, or how things should be done, that is, they are not based on related work and research methodologies. Finally, experience papers tell the experiences and reflections of the authors, as well as the benefits and disadvantages of a solution.

From 2014 to August 2020, the number of publications decreased, with six proposals of solution and one evaluation research. Over 24 years, most of the studies were proposals of solution, followed by evaluation studies.

3.2.2. Benefits of the Adoption of EUD by Organizations (SQ2)

In total, 13 studies were mapped. Most of them are proposals of solution (seven studies) and evaluation studies (four studies). The other two studies are one philosophical paper and one experience paper. Table 3 lists the 13 benefits recorded in this study. The most mentioned ones are support for decision-making (mentioned five times) and reduced dependence on IT, increased end-user productivity and increased end-user satisfaction (mentioned three times). The other benefits were cited only once or twice.

Table 3. SQ2—List of benefits.

Benefit	Studies
Support for decision-making	[S01], [S04], [S11], [S18], [S25]
Reduced dependence on IT	[S01], [S05], [S26]
Increased end-user productivity	[S01], [S25], [S29]
Increased end-user satisfaction	[S01], [S26], [S28]
Better use of the IT system and infrastructure	[S10], [S27]
Formalization of EUD development	[S18], [S26]
Decrease in communication problems	[S18], [S19]
Chance to compose business processes	[S11]
Decrease in end-user service time	[S24]
Improvement in business requisites	[S01]
Decrease in maintenance costs	[S19]
Deeper understanding of the models	[S29]
Elimination of errors without the interference of software specialists	[S29]

3.2.3. Barriers to the Adoption of EUD by Organizations

As for the barriers to the adoption of EUD by organizations (SQ3), most of the studies are proposals of solution (13 studies). The approaches opinion paper and experience paper have one publication each. Table 4 lists a set of 17 barriers. The most mentioned ones are lack of training and support for the end-user (both mentioned five times) and need for technological support (mentioned three times). The other barriers were mentioned only once or twice.

Table 4. SQ3—List of barriers.

Barrier	Studies
Lack of training for end-users	[S01], [S03], [S06], [S12], [S24]
Lack of support for end-users	[S01], [S15], [S22], [S29], [S30]
Need for technological support	[S23], [S28], [S29]
Lack of knowledge and skills of end-users	[S02], [S24]
The applications developed may not be tested	[S01], [S22]
Lack of quality or poor quality of the applications	[S03], [S25]
Lack of data security	[S01], [S22]
Non-effective use of EUD	[S01], [S02]
Lack of end-user commitment with EUD	[S07]
Duplication of efforts in the development of applications	[S03]
Communication problems between IT and end-users	[S02]
Lack of a career plan for professionals of EUD support	[S02]
Lack of organizational integration with EUD	[S02]
Use of rules and regulations	[S23]
Complex systems are not contemplated	[S07]
Difficulty to customize the application	[S14]
Complex domains may demand complex approaches	[S30]

3.2.4. Evaluation of the Results of the Adoption of EUD in Organizations

Half of the studies (15) assess the results of the adoption of EUD strategies by organizations (SQ4). There are nine proposals of solution, five evaluation studies and one validation study. Further details on the evaluation of results in the selected papers are presented in Section 4.

3.2.5. EUD Processes, Methods and Techniques Adopted in the Organizational Context (SQ1)

Also in Figure 4, it is observed that the processes, methods or techniques for the adoption of EUD by organizations (SQ1) appear mostly as proposals of solution (14 studies); three studies present evaluation research, one study consists of validation research, and one study reports an experience. Table 5 lists the set of methods and techniques found in this study.

4. Mapping Study—Qualitative Analysis

The following sections describe the main findings of the papers analyzed in this review.

4.1. What Are the Processes, Methods and Techniques Used in the Adoption of EUD by Organizations? (SQ1)

These concepts were defined as follows:

- Processes—clearly defined processes, which have a beginning and an end, as well as entries and exits;
- Methods—a set of techniques, approaches, or frames which involve more than a concept related to EUD, approaching it as a whole;
- Techniques—an individual technique, which does not demand the full involvement of EUD, but rather presents a point solution.

Table 4 lists the processes, methods and techniques of EUD found in this systematic literature mapping. The field 'original classification' registers the original nomenclature used by the authors and the field 'class' discloses the classification adopted in this review.

Most studies do not explain the scope of application of EUD strategies in the organizations (79%—[S01]–[S03], [S08]–[S10], [S13], [S17], [S20], [S21], [S24] and [S28]–[S30]). Thus, it is assumed that they can be adopted in several organizational contexts, unlike the strategies of the other studies ([S07], [S11], [S14], [S16] and [S19]), which are geared towards small and medium-sized enterprises, according to their authors.

Table 5. Papers that answer SQ1.

Classification (SQ1)	Original Classification	Brief Description	Assessment of Results	Paper
Method	Framework	Framework that uses the Total Quality of Management (TQM) to solve problems and risks produced by the adoption of EUD	No	[S01]
Method	Structure	Structure to support tools that allow end-users to create and modify applications and mechanisms that allow for the execution of the applications developed. The structure is based on the Component Based E-Application Deployment Shell (CBEADS), which allows for end-users to join, implement, and execute web components	No	[S07]
Method	Meta-model	Hierarchical meta-model to support development by end-users, with three levels of abstraction: shell, application, and function	No	[S09]
Method	Approach	Approach for the extension of Content Management System (CMS) in a set of EUD techniques, which focus on the use of CMS to create content for electronic government websites	Yes	[S13]
Method	Approach	Approach to develop software and prototype environments that use the lightweight visual design paradigm conducted by end-users	Yes	[S14]
Method	Meta-model	Meta-model based on the meta-design paradigm to develop several types of web applications, composed of: adequate infrastructure for the development and evolution of systems by the end-users; a learning environment for end-users; and a socio-technical environment that allows for end-users and professional developers to collaborate with each other	Yes	[S16]
Method	Environment	Modelling environment for business processes, named Simple Service Orchestration (SiSO), which models and adapts business process in the context of ERP systems	Yes	[S19]
Method	Framework	Framework that simplifies the development and maintenance of collaborative systems, makes it easier to insert end-users in development, and allows users to customize collaborative software	No	[S20]
Method	Approach	Lightweight event-driven model, in which end-users compose the resources in a logical sequence, which are monitored and automatically executed in a framework	Yes	[S21]

Table 5. *Cont.*

Classification (SQ1)	Original Classification	Brief Description	Assessment of Results	Paper
Method	Environment	Structure for the development of services by the pharmacy team, allowing for a more dynamic system, adapted to the hospital infrastructure	Yes	[S24]
Method	Platform	Platform, called TEMPEST, which supports specialists in the creation of their own studies of Ecological Momentary Assessment (EMA), following an end-user development approach	Yes	[S28]
Technique	Technique	A job rotation consisting of a temporary change in the work assignment of employees, usually associated with a change of department or title. Above all, it does not indicate an increase in the organizational hierarchy or status level in the organization	No	[S02]
Technique	Strategy	Strategies with which organizations may try to reduce problems associated with EUD based on information system methodologies	Partially	[S03]
Technique	Technique	A technique by which superusers (EUD) aid in the implementation of complex computational applications in organizations. Superusers are regular employees who have a thorough knowledge of one or more of the applications of the organization without being programmers	Yes	[S08] and [S10]
Technique	Techniques	EUD for processes: BPM approaches, Collaborative Task Manager (CTM), Programming by Example, Formal Process Models. EUD for data: WCP (Widget Composition Platform), SQD (Semantic Query Designer), Semantic Layer and Visual Query Proposition	No	[S11]
Technique	Technique	Parametrization technique consisting of activities that allow for end-users to choose between alternative behaviors available in the app, which results in the association of specific parameters to specific parts of data and codes or in the application of different functionalities	Yes	[S17]
Technique	Tools	Encouraging end-users of Domain-Specific Modeling Languages (DSML) to understand the development of DSML with tool support	No	[S29]
Technique	Evaluation and Prototype	Exploration of the needs of archivists of resources for end-user development in their systems for environmental monitoring and building of an open-source system prototype	Yes	[S30]

4.1.1. Processes

According to the categorization proposed in this study, none of the publications had strategies classified as processes. The concepts found did not have the features of a process, such as well-defined entries, exits, products, beginnings and ends.

4.1.2. Methods

Most publications—63% (10 studies)—were classified as methods, for they had more than one EUD key concept. The proposals addressed in these publications present not only technical issues related to technologies, but also socio-technical issues associated with end-users.

The methods identified are used in several contexts and in different ways. For example, in [S01] Total Quality Management (TQM) is used to mitigate risks involved in the adoption of EUD. The authors of [S20] set a framework to help insert end-users in the development of collaborative systems in dynamic environments, allowing them to customize software.

In [S07], the authors present difficulties faced by small and medium-sized enterprises when implementing web systems. As a solution, an EUD approach is proposed based on reusable components that can be incorporated into the organizations.

Studies [S21], [S14] and [S16] share a common challenge: to meet the needs of end-users in the organizational context. To do so, the authors of [S21] present a lightweight event-driven model-oriented approach, where end-users compose the resources in a logical sequence, which are monitored and automatically executed in a framework. In [S14], the authors present an approach to software development and prototype environments that uses the lightweight visual design paradigm conducted by end-users. And, in [S16], the authors propose a meta-model based on the meta-design paradigm to develop varied types of web applications.

In [S13], the authors present a case related to an EUD context involving the need to create content for the electronic government website of a municipality in Italy, unlike [S09], where EUD is treated as a problem-solving strategy related to business organizations, which use web applications to support their business processes. The author of [S13] offers an approach to extend Content Management System (CMS) in a set of EUD techniques [S17] [S10] that support content creation for the web. The authors of [S09] propose a hierarchical metamodel to support EUD.

In [S24], the authors present the development of an intelligent environment implemented to track drugs and people in a hospital pharmacy. According to them, the service development environment proposed could be easily used by non-computer science experts and users with no programming skills.

In the study [S19], the authors present a gap in the production of business processes using professional business process modeling tools and Service-Oriented Architectures (SOA). The flexibility of technologies that allow for the composition of business process systems is questioned by the authors. In this context, the business process modeling environment Simple Service Orchestration (SiSO) is presented, which models and adapts business processes in ERP systems.

Finally, the authors in [S28] present a paradigm for the organization of an Ecological Momentary Assessment (EMA) system for the purpose of in situ data collection. A platform called TEMPEST was built to support domain specialists create their own EMA studies, using and EUD approach.

4.1.3. Techniques

The classification as a 'technique' is characterized by the focus on an isolated technique that has not necessarily been presented within a set of EUD parameters. The application of these techniques may vary depending on the organizational context. The studies classified as techniques correspond to 37% (6 studies) of the publications selected for this systematic literature mapping. They comprise an individual technique, which presents a point solution, without the need to fully involve EUD concepts.

The techniques presented in [S03], [S11] and [S02] have a more managerial view and are associated with a high level of abstraction. In [S03], the authors identified a set of strategies that can be used in organizations that wish to adopt EUD. These strategies seek to reduce problems associated with EUD using information system methodologies—for example, by allowing end-users to develop their own information systems methodology. This is also explored in [S11], which presents a set of studies aiming to improve the ability of small and medium-sized enterprises to adapt their software systems to individual needs and changes.

The authors point out that a relevant aspect to improve EUD activities in organizations is to allow end-users to make business decisions more quickly and assertively based on their needs and the adaptive applications for data retrieval and analysis.

The technique presented by [S02] focuses on the optimization of the benefits obtained with the adoption of EUD in the organization. Job rotation is proposed, which consists of a temporary change in work assignment to the staff, usually associated with a department or functional change.

The techniques presented in [S17] and [S10] enable end-users to perform programming activities. For example, the technique of [S17] is to request HTML code accessibility parameters simply and intuitively, by means of a dialogue window during CMS editing. Thus, users are encouraged to insert these parameters visually in the dialogue window, narrowing the gap between the end-user and the application code.

In [S10], the authors present a technique focused on having the aid of superusers in the implementation of complex computational applications in organizations. Superusers, who have mastered the business and information technology skills, are defined as regular employees who are not programmers, but have a thorough knowledge of one or more of the applications of the organization.

The authors of [S29] propose and encourage the use of common tools in software engineering in the development of DSML by end-users. The authors show that these programming tools are necessary for end-users, as they can guarantee the proper functioning of the products developed. The tools presented by the authors are: Labybird, a debugging tool; SeTT, which allows the creation of test cases to test models in combination with hardware; and RTool, which allows the restructuring of measurement procedures.

In [S30], the authors found that archival professionals had emerging needs that were poorly supported by traditional systems, such as the customization of data reports and devices for exchanging parts. Based on these emerging needs, an open-source system prototype was developed, which enables archival professionals to monitor the environmental conditions of their collections, either in person or remotely, with a focus on the ability to modify the system by end-users in the domain of the Internet of Things (IoT).

4.2. (SQ2) What Are the Benefits of the Adoption of EUD by Organizations?

What motivates or influences an organization to adopt EUD is related to the benefits expected. In the papers analyzed in this study, the benefits were classified as:

- Human factors: advantages that have a direct impact on end-users and developers;
- Organizational factors: advantages that have a primary impact on the organization.

Table 6 lists the set of benefits associated with each factor.

Table 6. Benefits obtained with the adoption of end-user development (EUD).

Benefits	Studies
Category: Human factors	
Support for decision-making	[S01], [S04], [S11], [S18], [S25]
Increased end-user productivity	[S01], [S25], [S29]
Increased end-user satisfaction	[S01], [S26], [S28]
Decrease in communication problems	[S18], [S19]
Better use of the IT system and infrastructure	[S10], [S27]
Formalization of EUD development	[S18], [S26]
Chance to compose business processes	[S11]
Decrease in end-user service time	[S24]
Deeper understanding of the models	[S29]
Elimination of errors without the interference of software specialists	[S29]
Category: Organizational factors	
Reduced dependence on IT	[S01], [S05], [S26]
Improvement in business requisites	[S01]
Decrease in maintenance costs	[S19]

4.2.1. Benefits Related to Human Factors

- Support for decision-making

The adoption of EUD helps managers and end-users to make decisions. In [S11], it is suggested that organizations need to evolve their systems to respond more quickly and effectively to the needs of users, since they can build and modify their systems according to their own needs. In this sense, end-users are given greater capacity and agility in decision-making at work, allowing them more freedom [S01].

In addition to supporting decision-making, the creation of EUD development environments helps collaborators to maintain an innovative stance [S25]. Furthermore, the provision of adequate training for both end-users and managers promotes a greater level of involvement in EUD [S04].

In [S18], it is suggested that EUD applications called situational applications (SA) are promising, though risky. They require a careful analysis of what aspects of the business process (such as users, costs, productivity etc.) may benefit from this development strategy, since they can be more organized with support from traditional IT.

- Increased end-user productivity

In [S25], the potential benefits of EUD are presented, mainly the increase of the productivity of end-users, which may be related to the adoption of EUD-based tools. The authors explain that the creation of EUD environments can stimulate the fast production of applications and improve decision-making capacity. Study [S01] corroborates by presenting increased productivity also as a benefit of EUD; however, details of this benefit are not explored.

The authors of S29 reported that domain specialists, who can be considered as end-users, justified the increased productivity based on the time spent developing a measurement process in the last years.

- Increased end-user satisfaction

The recognition and officialization of EUD in the organization make end-users more satisfied with the services provided by IT and promote greater user involvement with IT [S01] and [S26].

Study [S28] evaluated the impact of using the TEMPEST platform and found satisfaction among end-users. In general, the platform provided versatility and ease of use by end-users. Decrease in communication problems. This is a benefit presented in [S19]. In the context described by the authors, end-users themselves are responsible for the elicitation of the requirements and implementation of the system. Therefore, the communication problems of the system requirements are minimized. However, the authors emphasize the importance of IT to accompany this process.

Study [S18] presents a way to optimize communication by creating the role of a local development coordinator in the EUD development process. Their responsibility is to perform EUD activities on a general level, supporting developer end-users and communicating with professional developers. In addition, they generalize local EUD results across the enterprise.

- Better use of the IT system and infrastructure

EUD enables better use of the systems, since they can be customized by end-users, adapting to their business needs [S10]. In addition, EUD not only provides a customized IT service for business units, but also enables organizations to evolve and optimize their IT infrastructure [S27].

- Formalization of EUD development

In the study carried out by [S26], the authors found that user developers existed even before the implementation of EUD, developing systems that met their daily needs, with technologies not standardized by IT. This informal development led to organizational problems, mainly related to the potential benefits derived from end-users that were not incorporated by the organization. In this context, the authors present the formalization of the departmental development by end-users as an organizational benefit, since this has encouraged the EUD of new applications standardized by IT in the organization.

In [S18], the institutionalization of superuser initiatives was placed as a criterion for the successful adoption of EUD. Thus, EUD was formalized by means of a contract that ensured superusers had time to carry out the activities required by their roles. This measure was aligned with the strategic decision to involve them in the process of implementing new systems.

- Chance to compose business processes

In [S11], the authors approach the need to offer developer users adequate techniques to proactively express knowledge on business processes, which comprise the know-how to solve potential problems. Based on that need, an important aspect for the optimization of business activities observed in the study is that nowadays organizations have to enable the composition of business processes from what was developed by end-users. That is, EUD can be used to achieve business objectives.

- Decrease in end-user service time

In [S24], which presents EUD in a clinical context, the pharmacy team create, develop and execute services to help manage and dispense medicine. Through statistical analysis, the authors verified that patients who participated in the test group (RFID card) of an EUD application took 17 s less in average to receive their medicine than patients with clinical prescriptions.

- Deeper understanding of the models

In study [S29], the authors conclude that common development tools in software engineering, such as a debugger, allows for a deeper understanding of DSML models, which are used by end-users to create programs.

- Elimination of errors without the interference of software specialists

The authors of [S29] argued that the use of software development tools by end-users enables them to eliminate errors in programming without the interference of software specialists, since these tools give more autonomy to end-users.

4.2.2. Benefits Related to Organizational Factors

- Reduced dependence on IT

In the studies presented in [S26] and [S05], the authors address the lack of IT resources to meet the demands of users as a gap in the organizational context. The EUD approach can be a motivation to address this gap.

In [S26], the implementation of EUD allowed the decentralization of IT, since low-priority systems were developed by end-users, which resulted in the business' less dependence on IT.

The authors of [S05] believe that research in EUD should be targeted to end-user developers rather than to IT. In this sense, the organization should focus on meeting the demands of business users, not just on reducing the IT development effort. The authors of [S01] mention that EUD reduces the backlog of the system, decreasing the dependence on information professionals.

- Improvement in business requisites

In [S01], the authors argue that the implementation of EUD improves both the elicitation of requirements by end-users and the business requirements. However, details of this benefit are not provided.

- Decrease in maintenance costs

According to [S19], when end-users are allowed to develop their own applications, the recurrent changes in traditional software development and its related costs are diminished, since user developers have a better perception of the requirements and their needs. Consequently, maintenance costs are reduced.

The reduced dependence on IT (organizational factor) and support for decision-making (the human factor) are the most mentioned benefits, which indicates they are motivational key points for adopting EUD in organizations. There are also situational benefits, which may not apply to all organizations, such as the formalization of EUD or the decrease in the service time of end-users.

4.3. (SQ3) What Are the Barriers to the Adoption of EUD by Organizations?

The organizations are impacted by factors that limit the use of EUD. As shown in Table 7, the barriers identified belong to three categories:

- People—the user developers;
- Processes–the processes, activities and products generated by EUD; and
- Technologies—the tools used for development by end-users.

Table 7. Barriers to the adoption of EUD.

Barriers	Studies
Category: People	
Lack of training for end-users	[S01], [S03], [S06], [S12], [S24]
Lack of support for end-users	[S01], [S15], [S22], [S29], [S30]
Lack of knowledge and skills of end-users	[S02], [S24]
Lack of end-user commitment with EUD	[S07]
Category: Processes	
The applications developed may not be tested	[S01], [S22]
Lack of quality or poor quality of the applications	[S03], [S25]
Lack of data security	[S01], [S22]
Non-effective use of EUD	[S01], [S02]
Duplication of efforts in the development of applications	[S03]
Communication problems between IT and end-user	[S02]
Lack of a career plan for professionals of EUD support	[S02]
Lack of organizational integration with EUD	[S02]
Use of rules and regulations	[S23]
Complex domains may demand complex approaches	[S30]
Category: Technology	
Need for technological support	[S23], [S28], [S29]
Complex systems are not contemplated	[S07]
Difficulty to customize the application	[S14]

4.3.1. Barriers Related to People

- Lack of training for end-users

For [S03] and [S01], most user developers receive little or no training. In general, the training initiatives undertaken by organizations are weak, and users learn to use the technologies without help. Moreover, these users are not usually trained to maintain the applications developed, which entails complications when these applications need to be evolved.

The training of end-users is important and should guide them to participate in the design phase during the development of EUD applications, as well as during its use, when the requirements can evolve [S12]. In [S24], the authors propose strategies to train the quality of EUD services, such as training and involving end-users in the development environment.

Investments to train users to develop EUD applications may incur more costs and time. However, these increased expenditures and time can be offset in the long run, resulting in significant improvements for the organization [S06].

- Lack of support for end-users

IT support for the developer user is essential [S22]. The authors affirm that organizations seek to support user developers struggling with applications and with little detailed information through helpdesks. While this is a low-cost solution, it does not help users to be more productive and efficient, or to properly develop their applications. Therefore, support for user developers should be the responsibility of the IT or business area of the organization. The authors of [S01] also mention the lack of support for end-users as a barrier to the adoption of EUD by organizations.

In [S15], a scenario is described in which IT has difficulties responding to the demands of business units, which take a reasonable time to be met. Also, the quality of the support is bad, and IT's reaction time is low.

In [S29], it was observed that end-users, like professional programmers, need support for the use of development tools. This support allows end-users to discover errors in their developed programs and to find DSML models more easily. The authors of [S30] suggest that the use of open source offers support to end-users through active communities in several layers of functionality, as well as for those who wish to make a full transition to the role of developers in the future.

- Lack of knowledge and skills of end-users

According to [S24], user developers need a set of knowledge and skills regarding the use of software packages, access to data, development of a database, privacy issues, preparation and use of the documentation, and so forth. Therefore, it is necessary to transfer knowledge between the IT area and the user developers. In addition, knowledge transfer is an opportunity for improvement, and forums and chats may be used to share knowledge, experiences and services [S02].

- Lack of end-user commitment with EUD

The authors of [S07] argue that the mindset of the end-user must change for EUD to be successful, that is, end-users should participate more and be more proactively in the design and development of EUD applications.

4.3.2. Barriers Related to Processes

- The applications developed may not be tested

In [S01] and [S22], it is argued that the spreadsheets developed by end-users are seldom tested, since few companies have policies that require the use of tests. However, spreadsheets developed by end-users, which mostly consist of chains of calculations, may contain errors that hinder decision-making in the organization.

- Lack of quality or poor quality of the applications

Few organizations seek quality assurance or quality control principles of systems developed by end-users. In [S03], the authors mention that most end-users do not seem to know the implications of lack of quality, unless the IT department warns them. Above all, low quality applications can hurt the organization's policies with respect to systems and data, as presented in [S25].

- Lack of data security

In [S22], information privacy is considered a point of concern. It is common for the applications developed by end-users to contain personally identifiable information, and the leakage of such information may be detrimental to the organization. Other security concerns are cyber-attacks, which increasingly focus on the theft of business secrets and application frauds, and lack of data integrity, according to [S01] and [S22].

- Non-effective use of EUD

The effectiveness of EUD is associated with the use of EUD technologies and their diffusion in the organization, as well as the end-users' understanding of the EUD technologies used by the organization [S02]. A lack of documentation of the systems developed and use of inadequate tools are problems faced by organizations [S01].

- Duplication of efforts in the development of applications

Unless end-users are aware of what other end-users are developing, data and processes may be duplicated. That is, different end-users sharing the same need for information may lead to rework [S03].

- Communication problems between IT and end-user

The IT unit and the business units fail to communicate because it is difficult to establish a connection between these two worlds. Above all, this gap contributes to a conflict between IT and end-user units in system development [S02].

- Lack of a career plan for professionals of EUD support

It is important to recognize and promote the career of those people who support user developers, regardless of if they are from the IT unit or the business unit, since the lack of sponsorship or professional promotion can de-motivate user supporters [S02].

- Lack of organizational integration with EUD

The authors of [S02] argue that organizational integration is a barrier, thus job rotation is one of the techniques used to encourage collaboration between end-users and IT professionals.

- Use of rules and regulations

The systems developed need to be validated by local regulations and legislation [S23].

Complex domains may demand complex approaches. The authors of [S30] report that there was an inevitable complexity in the needs of the scenario—in that study, the IoT—to address various technologies, such as sensors, microcontrollers, databases and protocols without thread. They further suggest that attention to designing for future breakdowns, managing exceptions, and allowing for the construction of new behaviors may be the most important dimensions to focus on EUD customization and extensibility in the future.

4.3.3. Barriers Related to Technologies

- Need for technological support

There is a need for technology that allows users to design and develop innovation. Thus, it is possible to reduce burdensome interaction and increase satisfaction with the solutions developed [S23].

Development tools with debugger functions, automated testing (testing tool), and restructuring of measurement procedures (refactoring tool) can support end-users during the development of DSML models [S29]. The lack of such tools can be one of the main

factors that prevent a wide acceptance of the Model-Driven Development (MDD), which is common in EUD in the software industry. Although these tools are essential, the authors emphasize that they must work at the level of abstraction of a domain that is familiar to the end-user.

In [S28], during the evaluation of the platform proposed, a malfunction of the systems produced was reported. However, it was found that the malfunction was due to a misunderstanding of the business domain (in the EMA protocol). This revealed that support tools, such as a debugger, are needed for the development of software by the end-user, giving them more autonomy in detecting programming errors.

- Complex systems are not contemplated

The authors in [S07] discuss the duality of development complexity and ease of use. According to the authors, most of the tools available for the development of web applications by end-users cannot develop complex applications that meet specific needs, since for the most part these tools focus on the construction of front-end and sometimes back-end components, which require more technical knowledge.

- Difficulty to customize the application

The creation of customized searches in databases that meet individual information needs is a challenge for user developers and the repetitive way of accessing databases may make it impossible to create custom interactive applications that meet the needs of user developers [S14].

4.4. SQ4—How Does One Assess the Outcomes of the Adoption of EUD by Organizations?

Half of the studies report the validation or evaluation of the outcomes obtained with the adoption of EUD. In this mapping, the evaluation methodologies included descriptive studies, exploratory studies and other methods. Table 8 summarizes the main characteristics of the evaluations reported in the studies. The fields indicating 'not reported' mean that the information was not explicitly stated in the publication.

Among the publications selected in this mapping, 11 were case studies. In [S04], [S14] and [S28], the studies are evaluated by means of questionnaires, and study [S30] used exploratory focus groups as assessment method. We believe [S13] and [S17] refer to the same study, for their results complement each other. Studies [S10] and [S08] address the same case published in the two studies.

Most of the cases deal with a commercial or business scenario in private organizations, with a focus on their business units. For example, [S21] presents the customization of business processes in an organization for the sale and maintenance of a heating system. Studies carried out in public organizations have similar focuses to those of private organizations, such as [S13], which is centered on the external business process (publication of government content to citizens), and [S26], which focuses on both internal and external processes.

Some publications do not present details regarding the method of evaluation, as in [S03], unlike [S19], which uses the techniques of observation and out loud thinking to validate the cases.

Table 8. Papers that respond to SQ4.

SQ	Type of Study	Country	Scenario	Number of Organizations Assessed	Type	Field	Number of Workers	Study
SQ1, SQ3	Case study	United Kingdom	Varied	34	Both	Several	7 to 30,000	[S03]
SQ2	Questionnaire application	Canada	Business process	5	3 banks and 2 insurance companies	Not informed	2200 to 57,000	[S04]
SQ1, SQ2	Case study	Scandinavia	Business process	1	Private	Accounting consulting	1.000	[S08] [S10]
SQ1	Case study	Italy	Commercial CMS	1	Public	Government	–	[S13]
SQ1, SQ3	Case of use	Germany	Business process	3	Not reported	2 production industries and 1 software supplier	137 to 500	[S14]
SQ1	Case study	Australia	Business processes	3	Private	Toolmaking industry	–	[S16]
SQ1	Case study	Italy	Commercial CMS	1	Public	Government	–	[S17]
SQ1, SQ2	Case study	Australia	Business process	1	Not reported	Not informed	–	[S19]
SQ1	Case study	Not reported	Commercial process	1	Private	Sale and maintenance of heating systems	–	[S21]
SQ1, SQ2, SQ3	Case study	Spain	Hospital Department	1	Not reported	Pharmacy	–	[S24]
SQ2	Case study	Brazil	Business process	1	Public	Government	–	[S26]
SQ2	Case study	Sweden and Japan	Business processes	2	Both	Telecommunications operator and UN-based university	–	[S27]
SQ1, SQ2, SQ3	Questionnaire	Not reported	Varied	18 individuals (not organizations)	Not reported	Varied	–	[S28]
SQ1, SQ3	Exploratory focus group	United States	Varied	4 individuals (not organizations)	Not reported	Cultural heritage (libraries, museums and galleries)	–	[S30]

5. Discussion

In this section, we interpret the results obtained in this systematic mapping, as well as the implications of the results for professionals and researchers that work with EUD.

5.1. EUD Strategies Adopted in the Organizations

The organizational context must be taken into account when developing and deploying EUD systems [44]. A possible solution to the EUD barriers in organizations is to exploit the full potential of EUD for becoming more flexible and powerful, allowing faster and more precise adaptations of IT-systems to support, for example, the setting up of project-specific team structures and collaborative processes. The EUD approaches must be properly embedded into the organizational environment to be interoperable with existing IT-systems, and thus to fully exploit the benefit of widespread EUD activities within the organization and to motivate end-users to actually carry out such activities.

No clearly defined EUD processes were found in this systematic literature mapping. It is assumed that the definition of the EUD process is not a normalized activity in organizations, since the definition and use of a process can make the activities inflexible during the development of solutions.

All publications selected in this systematic literature mapping present EUD strategies whether for small, medium, or large organizations. The strategies adopted are conceptualized as a framework ([S01], [S20]), an approach ([S13], [S14], [S21]), strategies ([S03]), a meta-model ([S09], [S16]), an environment ([S19], [S24]), a structure ([S07]) or a platform ([S28]). They either apply specific techniques to the EUD context ([S08], [S10], [S11], [S17]), tools ([S29]), evaluation and prototype ([S30]) or operate in a context that is not specific to the research field in EUD, but supports it ([S02]).

The strategies identified were classified as processes, methods and techniques according to the criteria defined in Section 4. It was found that some strategies may be applied, for example, to manage risks ([S01]) and reduce problems ([S03]) associated with the adoption of EUD. Some strategies have a technical context, focusing on the development of systems ([S09], [S14], [S16], [S21], [S24], [S28]–[S30]); the maintenance of EUD systems ([S07], [S20]); business processes modeling ([S19]); creation of applications based on the composition of resources ([S07], [S08], [S10], [S11], [S19], [S21]); or support to development tools ([S07]).

The development of systems ([S09], [S14], [S16], [S21], [S24], [S28]–[S30]) is the strategy most found in the publications, which was expected. The composition of services or systems ([S07], [S08], [S10], [S11], [S19], [S21]) is the second strategy most found in the publications. This may be related to the ease of development, customization and integration of end-users into the development process, since this strategy enables mutual collaboration between the IT department and the business units.

In [S01], a broad study is presented which involves other contexts besides EUD. Because of that, details of the problems and risks associated with the adoption of EUD are not found.

The benefits and barriers were extracted from the publications regardless if they were the conclusions of the authors or if they were cited from other publications not selected in our mapping. As an example, in [S25], the benefit of increased user productivity is presented as a cited work.

5.2. Research Approaches and Assessment of the Results of the Publications

Half of the papers selected in this systematic literature mapping evaluate the results obtained with the adoption of EUD. The remaining papers cite the benefits and barriers of other studies and associate the outcomes obtained in their study with the results of other publications. In this study, we did not consider it as a mechanism for the evaluation of results.

The case study is the main research method used to evaluate the outcomes of the adoption of EUD strategies. However, details on the protocol of these studies are not widely presented.

6. Conclusions

In our systematic mapping, we searched for relevant studies in the main database of publications in the computing area, and selected 30 papers. Based on the data we extracted, we were able to understand the main EUD strategies adopted by organizations, as well as the benefits and barriers to their adoption. Also, we had a general view of how the results obtained are assessed in the publications.

For the most part, EUD strategies focus on EUD management issues, such as risk management, or on more technical aspects, such as the implementation of components for EUD applications.

We found that there has been a small number of publications over the years regarding the adoption of EUD strategies by organizations although, since 2007, with the exception of 2014, at least one study has been published per year.

The proposal of a solution is the approach with the largest number of publications. Methods are more commonly found, and processes are not commonly found in the publications. The main method used by the authors to assess the results of their studies is the case study.

The benefits from the adoption of EUD can be classified into two types—human factors and organizational factors. The barriers that can impact the adoption of EUD can be related to the people, the processes and the technologies.

Support for decision-making, reduced dependence on IT, increased end-user productivity and increased end-user satisfaction are the most mentioned benefits of the adoption of EUD in the selected journals. On the other hand, lack of training for end-users, lack of support for end-users and the need for technological support were the most cited barriers in the publications selected.

From the discussions presented in Section 5, we reinforce the need to carry out more research on the adoption of EUD in organizations, with a high level of evidence to validate the results. The definition of EUD processes can also be considered a common gap in EUD research. This systematic literature mapping contributed as a framework to the knowledge about EUD in the organizational context and for organizations, as a set of information that can support their adoption.

Author Contributions: Data curation, A.S.C.M., R.M.d.C.F., C.S.R. and E.V.; project administration, R.M.d.C.F.; supervision, R.M.d.C.F. and G.V.P.; writing—original draft preparation, A.S.C.M., R.M.d.C.F., C.S.R. and E.V.; writing—review and editing, G.V.P. and L.d.S.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CMS	Content Management System
EUD	End User Development
EC	Exclusion Criteria
IC	Inclusion Criteria
IT	Information Technology
SQ	Secondary Question

References

1. Macías, J.A. Development of end-user-centered EUD software. In Proceedings of the 13th International Conference on Interacción Persona-Ordenador, Elche, Spain, 3–5 October 2012. [CrossRef]
2. Jennex, M.E. End-User System Development. *J. Cases Inf. Technol.* **2005**, *7*, 67–81. [CrossRef]

3. Lieberman, H.; Paternò, F.; Klann, M.; Wulf, V. End-User Development: An Emerging Paradigm. In *Human-Computer Interaction Series*; Springer: Amsterdam, The Netherlands, 2003. [CrossRef]
4. Ghaoui, C. *Encyclopedia of Human Computer Interaction*; Information Science Reference; IGI Publishing: Hershey, PA, USA, 2005.
5. Stolee, K.T.; Elbaum, S.; Sarma, A. End-User Programmers and their Communities: An Artifact-based Analysis. In Proceedings of the 2011 International Symposium on Empirical Software Engineering and Measurement, Banff, AB, Canada, 22–23 September 2011. [CrossRef]
6. Mehandjiev, N.; Sutcliffe, A.; Lee, D. Organizational View of End-User Development. In *Human-Computer Interaction Series*; Springer: Amsterdam, The Netherlands, 2006; pp. 371–399. [CrossRef]
7. Tetteroo, D.; Markopoulos, P. A Review of Research Methods in End User Development. In *End-User Development*; Springer International Publishing: Berlin/Heidelberg, Germany, 2015; pp. 58–75. [CrossRef]
8. McLean, E.R. End Users as Application Developers. *MIS Q.* **1979**, *3*, 37. [CrossRef]
9. Hang, F.; Zhao, L. Supporting End-User Service Composition: A Systematic Review of Current Activities and Tools. In Proceedings of the 2015 IEEE International Conference on Web Services, New York, NY, USA, 27 June–2 July 2015. [CrossRef]
10. Kitchenham, B.; Brereton, O.P.; Budgen, D.; Turner, M.; Bailey, J.; Linkman, S. Systematic literature reviews in software engineering—A systematic literature review. *Inf. Softw. Technol.* **2009**, *51*, 7–15. [CrossRef]
11. Petersen, K.; Feldt, R.; Mujtaba, S.; Mattsson, M. *Systematic Mapping Studies in Software Engineering*; BCS Learning & Development Ltd.: London, UK, 2008; pp. 68–77.
12. Petticrew, M.; Roberts, H. (Eds.) *Systematic Reviews in the Social Sciences*; Blackwell Publishing Ltd.: Hoboken, NJ, USA, 2006. [CrossRef]
13. Chang, P.L.; Shen, P.D. A conceptual framework for managing end-user computing by the total quality management strategy. *Total Qual. Manag.* **1997**, *8*, 91–102. [CrossRef]
14. Selmi, S.S.; Kraiem, N.; Ghezala, H.B. Toward a Comprehension View of Web Engineering. In *Lecture Notes in Computer Science*; Springer: Berlin/Heidelberg, Germany, 2005; pp. 19–29. [CrossRef]
15. Fogli, D. End-User Development for E-Government Website Content Creation. In *End-User Development*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 126–145. [CrossRef]
16. Dörner, C.; Yetim, F.; Pipek, V.; Wulf, V. Supporting business process experts in tailoring business processes. *Interact. Comput.* **2011**, *23*, 226–238. [CrossRef]
17. Ruhi, U. Towards a Framework for Enterprise End-User Development Initiatives: A Design Science Research Investigation. Available online: https://aisel.aisnet.org/amcis2015/EndUser/GeneralPresentations/9/ (accessed on 26 January 2021).
18. Moore, J.E. The Application of Job Rotation in End User Computing. *J. Organ. End User Comput.* **1997**, *9*, 4–14. [CrossRef]
19. Asand, H.R.H.; Morch, A.I. Super Users and Local Developers. *J. Organ. End User Comput.* **2006**, *18*, 1–21. [CrossRef]
20. Spahn, M.; Wulf, V. End-User Development of Enterprise Widgets. In *End-User Development*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 106–125. [CrossRef]
21. Antonaya, S.L.; Bravo, C.; Gallardo, J. A framework for the development of organizational collaborative systems. In Proceedings of the 13th International Conference on Interacción Persona-Ordenador, Elche, Spain, 3–5 October 2012. [CrossRef]
22. França, A.; Figueiredo, R.; Venson, E.; Silva, W. Storytelling on the implementation of a Decentralized Model for Software Development in a Brazilian Government Body. In Proceedings of the 17th International Digital Government Research Conference on Digital Government Research, Shanghai, China, 8–10 June 2016.
23. Taylor, M.J.; Moynihan, E.P.; Wood-Harper, A.T. End-user computing and information systems methodologies. *Inf. Syst. J.* **1998**, *8*, 85–96.
24. De Silva, B.; Ginige, A. Solving Design Issues in Web Meta-Model Approach to Support End-User Development. In Proceedings of the Second International Conference on Software and Data Technologies. SciTePress—Science and and Technology Publications, Barcelona, Spain, 22–25 June 2007. [CrossRef]
25. Büchel, B.; Janner, T.; Schroth, C.; Hoyer, V. Enterprise mashup vs. service composition: What fits to reach the next stage in end-user development? In *Proceedings of the WM2009: 5th Conference on Professional Knowledge Management*; Hinkelmann, K., Wache, H., Eds.; Gesellschaft für Informatik e.V.: Bonn, Germany, 2009; pp. 260–264.
26. Xue, S.; Wu, B.; Chen, J. An End-User Oriented Approach for Business Process Personalization from Multiple Sources. In *Service-Oriented Computing*; Springer: Berlin/Heidelberg, Germany, 2013; pp. 87–98. [CrossRef]
27. Dittrich, Y.; Bolmsten, J.; Eriksson, J. End User Development and Infrastructuring—Sustaining Organizational Innovation Capabilities. In *New Perspectives in End-User Development*; Springer International Publishing: Berlin/Heidelberg, Germany, 2017; pp. 165–206. [CrossRef]
28. Blili, S.; Raymond, L.; Rivard, S. Impact of task uncertainty, end-user involvement, and competence on the success of end-user computing. *Inf. Manag.* **1998**, *33*, 137–153. [CrossRef]
29. Asand, H.R.H.; Morch, A.I. The Organization of End User Development in an Accounting Company. In *Advances in End User Computing*; IGI Global: Hershey, PA, USA, 2007; pp. 102–123. [CrossRef]
30. Silva, B.D.; Ginige, A. Study of Using the Meta-model Based Meta-design Paradigm for Developing and Maintaining Web Applications. In *Lecture Notes in Business Information Processing*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 304–314. [CrossRef]

31. Panko, R.R.; Port, D.N. End User Computing: The Dark Matter (and Dark Energy) of Corporate IT. In Proceedings of the 2012 45th Hawaii International Conference on System Sciences, Maui, HI, USA, 4–7 January 2012. [CrossRef]
32. Batalas, N.; Aan het Rot, M.; Khan, V.J.; Markopoulos, P. Using TEMPEST. In Proceedings of the ACM on Human-Computer Interaction, Barcelona, Spain, 3–6 September 2018. [CrossRef]
33. McBride, N.; Wood-Harper, A.T. Towards User-Oriented Control of End-User Computing in Large Organizations. *J. Organ. End User Comput.* **2002**, *14*, 33–41. [CrossRef]
34. Stoitsev, T.; Spahn, M.; Scheidl, S. EUD for enterprise process and information management. In *Proceedings of the 4th International Workshop on End-User Software Engineering*; Association for Computing Machinery: New York, NY, USA, 2008. [CrossRef]
35. Fogli, D.; Colosio, S.; Sacco, M. Managing accessibility in local e-government websites through end-user development: A case study. *Univers. Access Inf. Soc.* **2009**, *9*, 35–50. [CrossRef]
36. Helena, L. Sociotechnical Systems as Innovation Systems in the Medical and Health Domain. *Stud. Health Technol. Inform.* **2013**, *194*, 35–40. [CrossRef]
37. Kos, T.; Mernik, M.; Kosar, T. A Tool Support for Model-Driven Development: An Industrial Case Study from a Measurement Domain. *Appl. Sci.* **2019**, *9*, 4553. [CrossRef]
38. Heng, M.S.H. Beyond End Users Computing. In Proceedings of the Fifth International Conference on Enterprise Information Systems, Angers, France, 23–26 April 2003; Volume 3, pp. 594–598.
39. Silva, B.D.; Ginige, A.; Bajaj, S.; Ekanayake, A.; Shirodkar, R.; Santa, M. A Tool to Support End-User Development of Web Applications Based on a Use Case Model. In *Lecture Notes in Computer Science*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 527–530. [CrossRef]
40. Maier, R.; Remus, U. Guiding Situational Applications from a Structuration Perspective. Available online: https://aisel.aisnet.org/acis2011/27/ (accessed on 26 January 2021).
41. Martín, D.; Alcarria, R.; Sánchez-Picot, Á.; Robles, T. An Ambient Intelligence Framework for End-User Service Provisioning in a Hospital Pharmacy: A Case Study. *J. Med Syst.* **2015**, *39*. [CrossRef] [PubMed]
42. Maceli, M.G. An Internet-of-Things End-User Development Approach to Environmental Monitoring of Cultural Heritage Archives. In *End-User Development*; Springer International Publishing: Berlin/Heidelberg, Germany, 2019; pp. 149–157. [CrossRef]
43. Wieringa, R.; Maiden, N.; Mead, N.; Rolland, C. Requirements engineering paper classification and evaluation criteria: A proposal and a discussion. *Requir. Eng.* **2005**, *11*, 102–107. [CrossRef]
44. Lieberman, H.; Paternò, F.; Wulf, V. *End User Development*; Springer: Berlin/Heidelberg, Germany, 2006.