2020

Translating Business Process Models to Class Diagrams

Matthijs Berkhout

Sam Leewis

Koen Smit

TRANSLATING BUSINESS PROCESS MODELS TO CLASS DIAGRAMS

A controlled experiment

MATTHIJS BERKHOUT[1], SAM LEEWIS[1] & KOEN SMIT[1]

[1] HU University of Applied Sciences Utrecht, Digital Ethics, the Netherlands, matthijs.berkhout@hu.nl, sam.leewis@hu.nl, koen.smit@hu.nl

Abstract Choreography of business processes can track messages between different services. At the time of writing, there are no guidelines to draw a UML Class Diagram from the Business Process Choreography. This paper reports an experiment using a set of guidelines. Objective: Evaluate the subjects' performance and perceptions when applying the BPc2Class-guidelines and BPc2Class-discovery process. Method: To measure the performance and user perception of both ways of mapping the processes, a comparative experiment was conducted with 38 subjects. The subjects, being master students, solved a process case in the first session and a guidelines case in the second session. A survey was filled in by the subjects to measure the user perception variables. Results: The results indicated that the guidelines showed significantly better results in five out of the six measured variables. Conclusion: Based on the findings and limitations of this research the use of guidelines looks promising, but future research is necessary to further generalize the conclusion.

Keywords: business process model, class diagram, translation, experiment, BPc2Class.

University of Maribor Press

DOI https://doi.org/10.18690/978-961-286-362-3.22
ISBN 978-961-286-362-3

1 Introduction

Following the model-driven-design (MDD) paradigm, static structures can be derived from business process models (Bentley, Ditmann, & Whitten, 2000). These business process models are drawn to assist organisations in dealing with all services and processes nowadays (Xu, 2011) and are commonly mapped using the Business Process Modelling and Notation (BPMN) standard (OMG (Object Management Group), 2015). This standard consists of numerous approaches to model business processes. The most common approach is to orchestrate business processes into a model, but there is also another approach. The choreography of business processes tracks the messages between different services (Peltz, 2003). From these Business Process Choreography (BPC) diagrams, the static structures in general and the UML Class Diagrams (CD) in particular may be derived (González, España, Ruiz, & Pastor, 2011).

Although research has been conducted on this aspect (González et al., 2011) there are no guidelines for the transformation of BPC diagrams to Class processes, which is referred to as BPc2Class. In this paper, a set of guidelines and a guiding process will be proposed and tested. To be able to do so, the following research questions have been devised:

RQ1: *Will the subjects applying the BPc2Class-discovery process show different performance results in the output models than the subjects applying the BPc2Class-guidelines?*
RQ2: *Will the subjects applying the BPc2Class-discovery process show different perceptions than the subjects applying the BPc2Class-guidelines?*

The main objective of this research is to analyse BPc2Class-guidelines and the BPc2Class-discovery process, concerning their performance and perception in order to create a traceability link between the BPC and the CD. The rest of the paper is structured as follows: section two presents a background and introduction of the BPMN and CD modelling methods. Section three describes the experiment design. Section four contains the results and section five consists of the analysis of the executed experiment. Then, in the last section the conclusion and future research directions are elaborated upon.

2 Background & Related work

Organisations are in need to manage their business processes (van der Aalst, 2013a). These processes are composed of multiple less complex sub-processes and activities that are interrelated and hold a vast amount of knowledge on specific domains of the organization (Kock Jr & McQueen, 1996). Davenport (1993) defines business processes as: "*structured, measured sets of activities designed to produce a specified output for a particular customer or market.*" Business processes can be very complex and rely heavily on information systems (Aguilar-Savén, 2004). Due to this, it has become important to model business processes. Process models assist in managing and understanding this complexity by providing diagrammatic notation of the processes, providing ways to discuss and improve them (van der Aalst, 2013b; van der Aalst, ter Hofstede, Weijters, & Weske, 2003). One of the effective ways to model business processes is through subject-oriented business process management (Fleischmann, 2014). This approach puts actors of processes at the centre of attention to deal with business processes. This gives a new perspective on the organisational environment and therefore helps meeting the requirements from organisations.

The modelling itself is usually supplemented by a notation standard, BPMN (Chinosi & Trombetta, 2012). The industry standard for modelling business processes is BPMN 2.0, but a more subject-oriented approach is the choreography of business processes, where messages are tracked between different services (Peltz, 2003).

Business processes help to define a business strategy, however, it is key that information technology is aligned to this business strategy (Henderson & Venkatraman, 1999). Therefore, it is important to design class diagrams which ensure that the information systems support the business processes. There are multiple ways to make sure this is the case, of which one of them is deriving the class diagrams from business process models. The alignment of business processes and class diagrams can be related to traceability in information systems. Traceability can provide insight into system development and top-down and bottom-up program comprehension (Lucia, Fasano, Oliveto, & Tortora, 2007). Gotel and Finkelstein (1994) analysed the problem in the requirement traceability domain. Requirements traceability in information systems refers to the ability to trace, describe and follow the path of a requirement in both a forwards and backwards direction (Gotel & Finkelstein, 1994). Gonzalez et al. (2011a) describe a method for deriving a Class

Diagram from business process models, e.g. a BPc diagram. Testing this method during lab demos has shown the value of this model, but also that this model requires optimization and extensive testing.

Some experiments have been conducted in the past regarding the field of requirements traceability. Shin and Sutcliffe (2005) studied the effectiveness of a tool for providing traceability between scenario models and requirements. Subjects that used the tool generated better scenarios, leading to improvements in requirements elicitation and validation.

The uniformity of domain models derived from Use Cases with respect to those that derive from InfoCase models is studied by Fortuna et al. (2008). They show that the use of InfoCase models can reduce the problem of inconsistency among domain models. España et al. (2009) also performed an experiment to evaluate requirements engineering methods, the methods being communication analysis and use cases. The use of communication analysis shows greater quality in completeness and granularity. A pilot experiment by España et al. (2011) analyses whether the OO-Method benefits from integration with Communication Analysis. They concluded that the pilot was promising and has the potential to verify that integrating Communication Analysis with the OO-method has benefits. The experiments mentioned above show that using experimental research provides insight into traceability dilemma's in research.

3 Experimental design

To answer the research questions the following two-sided hypotheses are formulated for each variable measured in the experiment, each H0 hypothesis has a corresponding alternative hypothesis H1:

Hypothesis 1

Null hypothesis, $H1_0$: The output models obtained from the BPc2Class-discovery process show the same degree of validity as the output models obtained from the BPc2Class-guidelines.

Hypothesis 2

Null hypothesis, $H2_0$: The output models obtained from the BPc2Class-discovery process show the same degree of completeness as the output models obtained from the BPc2Class-guidelines.

Hypothesis 3

Null hypothesis, $H3_0$: The output models obtained from the BPc2Class-discovery process show the same degree of efficiency as the output models obtained from the BPc2Class-guidelines.

Hypothesis 4

Null hypothesis, $H4_0$: The level of usefulness is the same for the BPc2Class-discovery process as the BPc2Class-guidelines.

Hypothesis 5

Null hypothesis, $H5_0$: The level of ease of use is the same for the BPc2Class-discovery process as the BPc2Class-guidelines.

Hypothesis 6

Null hypothesis, $H6_0$: The level of intention to use is the same for the BPc2Class-discovery process as the BPc2Class-guidelines.

3.1 Variables

This research identifies two types of variables (Wohlin et al., 2012), the response variables and the factors and treatments. The response variables are related to the effects studied in the experiment caused by the manipulation of independent variables (Juristo & Moreno, 2001). This research decomposes the response variables in performance response variables and perception response variables which are derived from literature analysis. Performance is divided into: 1) Validity, 2) Completeness and 3) Efficiency. Perception is divided into 1) Usefulness, 2) Ease of use and 3) Intention to use.

The factors and treatments (also artefacts) are the independent variables whose effect on response variables this research wants to understand (Juristo & Moreno, 2001). The factor level consists of two factors: 1) Traceability strategy and 2) Input models. The treatments or artefacts in this research are the different strategies namely: BPc2Class guidelines and the BPc2Class discovery process, and the input models. These models consist of Business Process Choreography models and UML Class Diagrams. Table 1 shows a summary of the research questions, hypotheses, response variables and metrics.

Table 1: Summary of RQs, hypotheses, response variables and metrics

RQ	Hypotheses	Response variables	Metric
RQ1	H1	Validity	M1. Comparison of output models
RQ1	H2	Completeness	M2. Comparison of output models
RQ1	H3	Efficiency	M3. Completeness/Time
RQ2	H4	Usefulness	M4. Likert scale
RQ2	H5	Ease of use	M5. Likert scale
RQ2	H6	Intention to use	M6. Likert scale

3.2 Experimental subjects

This study is conducted among a group of master students from a university in the Netherlands. All subjects filled out a demographic questionnaire, prior to running the experiment, in order to characterise the population. The subjects rated their knowledge in Business process modelling and UML diagrams on a 5-point- Likert scale (where 1 is low and 5 is high). Subjects with a three (average) or higher on a 5-

point-Likert scale can be considered to have good knowledge of the technique. The results state that 71% of the subjects have good knowledge of Business Process Modelling and 76% have good knowledge of UML diagrams. The subjects are also asked if they have any experience regarding conceptual modelling or requirements engineering. Out of the 38 subjects, 63% said that they have experience with conceptual modelling or requirements engineering through, for example, courses, but no students have real work experience within an organisation in this field. From the subjects, 37% said they have no experience with conceptual modelling or requirements engineering.

The choice for this group of subjects has been made based on two reasons. First, Höst et al. (Host, Regnell, & Wohlin, 2000) describe that the differences between students and professionals are only minor. The second reason is the exploratory nature of this research as no previous experiments in this context have been found to the knowledge of the researcher.

3.3 Experimental objects and instruments

The experiment intends to measure the difference between two treatments, the BPc2Class discovery process and the BPc2Class guidelines. Both treatments are drafts, based on the works of Espana et al (2012) and aim to support professionals in completing the experimental task, that is, deriving a Class Diagram from a communication-oriented business process model.

The first experimental object, the discovery process, defines a 5-step process to guide the process of discovering and improving traceability links between a BPc and a Class Diagram. The second experimental object, the guidelines, provides a systematic technique for deriving a Class Diagram from a BPc. These guidelines consist of 12 steps, through which a complete Class Diagram is created. These treatments are tested on two input models per treatment; therefore, this experiment requires four test cases, two for each session as shown in Table 2. Due to space limitations, these guidelines are available upon request.

Table 2: The design used in the experiment: 2^4 factorial design

	Treatment 1		Treatment 2	
	Artefact A_1	**Artefact B_1**	**Artefact A_2**	**Artefact B_2**
Session 1	Subjects 1-19	Subjects 20-38	X	X
Session 2	X	X	Subjects 1-19	Subjects 20-38

Because the size and complexity of the treatments impact the test results (Basili et al., 1996), and therefore could threaten the internal validity, isomorphic models are used, i.e., the models A_1 and B_1, which are used for the guidelines, are isomorphic to respectively A_2 and B_2. For example, case A_1 uses the context of a hiring process for a company, whereas case A_2 is the enrolment procedure at an educational institute. A summary of these experimental objects can be found in Table 3.

Table 3: Summary of experimental objects

Factor	Artefacts	Objects
Traceability strategy	Guidelines	BPc2Class guidelines
	Process	BPc2Class discovery process
Input model	A_1	BPc_1
	A_2	Isomorphic BPc_1 + 40% UML CD
	B_1	BPc_2
	B_2	Isomorphic BPc_2 + 40% UML CD

Aside from the experimental objects, the subjects received guidelines for executing the experiment. These guidelines included a short description of the input models and the required output models. To measure the metrics, given in table 2, several tools are used. The first two variables, Validity and Completeness, will be based on a comparison between the input- and output models and scored on a scale of 0 to 100%. The measurement method for these variables is based on the quality model framework by Lindland et al. (1994).

The measurement of time is done by the subjects as part of the experiment and is done using a chronometer. The completeness of the model is then divided by the time to calculate the efficiency, Panach et al. (2015) show a similar method for calculating efficiency. For assessing the usefulness, ease of use and intention to use, a survey will be held among the subjects. This survey is based on the Method

Evaluation Model by Moody (2003). Table 4 shows a summary of all variables and the experimental objects and tools related to these variables.

Table:4: Summary of experimental objects and tools

Variables	Metric	Tools and instruments
Validity	Comparison of output models	The quality model framework (Lindland et al., 1994)
Completeness	Comparison of output models	The quality model framework (Lindland et al., 1994)
Efficiency	Completeness/Time	Chronometer
Usefulness	Likert scale	Survey based on Moody (2003)
Ease of use	Likert scale	Survey based on Moody (2003)
Intention to use	Likert scale	Survey based on Moody (2003)

3.4 Experimental procedure

All subjects filled in a demographic questionnaire before the experiment to determine if the target audience is reached and to identify the subject's background.

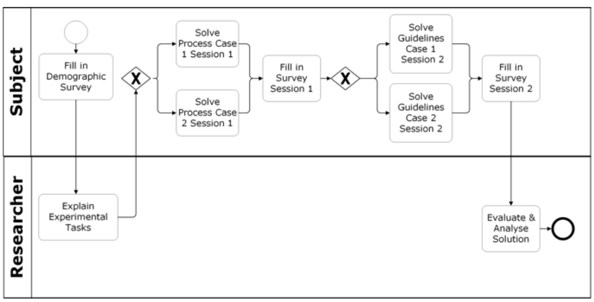

Figure 1: Summary of the experimental procedure

The experiment itself was conducted in two sessions, spread over the first two weeks of the course. Both sessions were two hours and were in the same room on the same day and time of the week with one week between assignment one and assignment two. The first session consists of an assignment where the subject creates a class diagram from a Business Process Choreography with the help of the BPc2Class-discovery process. The subject receives a partial class diagram and should complete this. The time subjects need for the assignment is measured and after the first session the subjects will fill in a survey to check what the ease of use, the usefulness and the intention of use are for the BPc2Class-discovery process. Session two starts with another assignment. This assignment consists of creating a class diagram from a Business Process Choreography with the help of BPc2Class-guidelines. The subject receives the process and the guidelines and should create a complete class diagram. During the solving of assignment two, the time a subject need for solving the assignment is measured again. After solving the second assignment another survey with questions about the ease of use, the usefulness and the intention of use of the BPc2Class-guidelines is filled in.

When the experiment is done, all data retrieved from all subjects will be shared among the researchers and will be evaluated and analysed. Figure 1 shows a summary of the experimental procedure.

4 Results

4.1 Descriptive statistics

After the experiment, all data was gathered in one data set. Out of this data set, the completeness, validity and efficiency were calculated. The user perception was taken from the survey results. Before calculating the value for each of the three perception values, the Cronbach's alpha was measured. In all cases, the internal validity was sufficient according to Cronbach's Alpha. After that, a Shapiro-Wilk test of normality was performed on the complete dataset. The only normally distributed metric was the perceived usefulness. The values for validity and completeness were given in percentages and the descriptive statistics already show a small difference in the validity and completeness between the process and the guidelines, as the results for the guidelines were slightly higher. The measured efficiency, which was given as a factor, calculated from the completeness and time consumed, was also slightly higher for the guidelines.

The metrics regarding user perception were measured using a five-point Likert scale and were therefore given as a value between 1 and 5. Except for the perceived intention to use the process, all metrics were slightly positive, with values ranging between 2.7 and 2.9. The perceived usefulness for the guidelines was slightly higher than the other metrics, with a value of 3.15.

The results for both the guidelines and the process were also analysed per case. Aside from the descriptive statistics, a Wilcoxon-Mann-Whitney-test was used to test whether the results from case 1 significantly differ from the results of case 2. For the BPc2Class-discovery process this was not the case, nor for the Completeness and Efficiency metrics of the guidelines.

4.2 Hypothesis testing

In order to answer the research questions, the hypotheses must be tested. This subchapter elaborates on that part. Per hypothesis, a statistical test was completed to assess whether there is a significant difference between the variables. Depending on whether the variable is normally distributed, the variable is tested with a non-parametric (Wilcoxon-Mann-Whitney) or a parametric (paired t-test) statistical test. First, the hypotheses from the first research question were tested, followed by the variables from the second research question seen in figure 2.

Hypothesis	Research Question	W-value	p-value
H1 (validity)	RQ1	969	0.0008
H2 (Completeness)	RQ1	848	0.0053
H3 (Efficiency)	RQ1	876	0.0015
H5 (Ease of Use)	RQ2	663	0.8655
H6 (Intention to use)	RQ2	517.5	0.0993

Hypothesis	Research Question	T-value	p-value
H4 (Usefulness)	RQ2	1.2532	0.2147

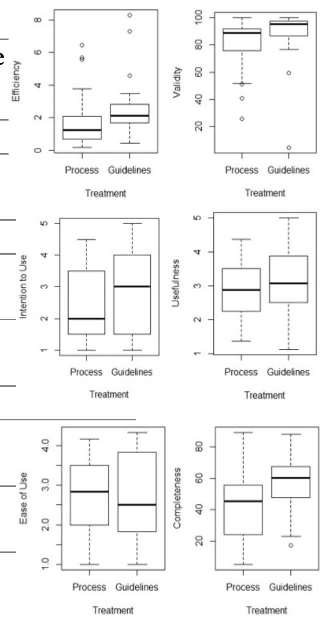

Figure 2: Results

Table 5 shows the retaining or rejection of the hypotheses for the variables:

Table 5: Hypothesis retained or rejected

Variable	Significant ($p<0.05$)	Retained/Rejected	Variable	Significant ($p>0.05$)	Retained/Rejected
Validity	Yes	Rejected	**Ease of Use**	No	Retained
Completeness	Yes	Rejected	**Intention to use**	No	Retained
Efficiency	Yes	Rejected	**Usefulness**	No	Retained

5 Future work

Since there was no literature found on the BPc2Class-discovery process and the BPc2Class-guidelines the results cannot be related to existing evidence on this particular subject. However, this experiment does show relations to existing research on the design and method of this experiment. The work presented in the related works showed similar controlled experiments in the research field of information systems traceability.

The research showed that variables based on the quality framework by Lindland et al. (Lindland et al., 1994) and the Method Evaluation Model by Moody (Moody, 2003) can be used to assess whether conceptual models have quality and to evaluate subjects perceptions and satisfaction. This is in line with the previous experiments done in information systems traceability and helps to extend the basis which the framework and model have for experimentation in information science.

By using the framework and model, this experiment compared the BPc2Class-discovery process with the BPc2Class-guidelines in terms of validity, completeness, efficiency, usefulness, ease of use and intention to use. The first research question is as follows:

RQ1: *Will the subjects applying the BPc2Class-discovery process show different performance results in the output models than the subjects applying the BPc2Class-guidelines?*

The first research question can be answered by looking at the first three hypothesis tests. The first three hypothesis tests were based on the variable's validity, completeness, and efficiency. All three tests showed a significant difference between the process and the guidelines, seen in figure 2. The data shows that the means from the guidelines are higher than the means of the process, which might suggest that the guidelines show better performance results than the process.

The second research question is as follows:

RQ2: *Will the subjects applying the BPc2Class-discovery process show different perceptions than the subjects applying the BPc2Class-guidelines?*

This research question can be answered by looking at the last three hypothesis tests. These tests involved the variables usefulness, ease of use, and intention to use. All three tests showed no significant difference between the process and the guidelines, seen in figure 2. Based on the findings of the tests, it can be concluded that the subjects do not have different perceptions of using the process or the guidelines.

For an experimental study, the results must be valid. This study suffered some validation threats. The first limitation appeared during the second session, as the subject had already undergone treatment from the first session. This could cause a construct validity error. Maturation is also a validity error that occurred as people are familiar with the process in the second session. This is partly avoided by using isomorphic models, but some threat still existed. The next limitation is the use of partly filled in models. This could cause a bias against the models without an example. Lastly, as the subject population consisted only of students it is not easily generalizable to other populations.

The future work suggested in this section is twofold, one being more empirical activities and the other a suggestion for a design project. The first suggestion for future empirical activities with the focus on Business Process Choreography and Class diagrams can be to have another group of subjects doing the experiment but to train them in advance. Next to the training and control group, the successive empirical activity could also involve more and more diverse subjects, especially using professional subjects. This will result in data that will be more generalizable. To make conclusions about whether guidelines are, in general, better than a process, more empirical activities with different conditions should be conducted.

The second suggestion for future work, after further validation of these results, could be conducting a design project. A possibility is translating the guidelines in automated software, the guidelines are then rules that have to be followed and implemented. When the guidelines are automated in software, empirical activities could be conducted to see whether this automated software show good results regarding traceability in information systems.

References

Aguilar-Savén, R. S. (2004). Business process modelling: Review and framework. International Journal of Production Economics, 90(2), 129–149. https://doi.org/10.1016/S0925-5273(03)00102-6

Basili, V. R., Green, S., Laitenberger, O., Shull, F., Sørumgård, S., & Zelkowitz, M. V. (1996). The Empirical Investigation of Perspective-based Reading. Empirical Software Engineering, 1, 133–164. https://doi.org/10.1007/BF00368702

Bentley, L. D., Ditmann, K. C., & Whitten, J. L. (2000). System Analysis and design methods. Irwin/McGraw Hill.

Chinosi, M., & Trombetta, A. (2012). BPMN: An introduction to the standard. Computer Standards and Interfaces, 34(1), 124–134. https://doi.org/10.1016/j.csi.2011.06.002

Davenport, T. H. (1993). Reengineering Work through Information Technology. Harvard Business School Press.

España, S., Condori-Fernandez, N., González, A., & Pastor, Ó. (2009). Evaluating the completeness and granularity of functional requirements specifications: A controlled experiment. Proceedings of the IEEE International Conference on Requirements Engineering, 161–170. https://doi.org/10.1109/RE.2009.33

España, S., Condori, N., Wieringa, R., González, A., & Pastor, Ó. (2011). Model-Driven System Development: Experimental Design and Report of the Pilot Experiment. Computer Research Repository, abs/1111.0, 83. Retrieved from http://arxiv.org/abs/1111.0562

España, S., Ruiz, M., & González, A. (2012). Systematic derivation of conceptual models from requirements models: A controlled experiment. Proceedings - International Conference on Research Challenges in Information Science, (April). https://doi.org/10.1109/RCIS.2012.6240428

Fleischmann, A. (2014). Subject-Oriented Business Process Management. https://doi.org/10.1007/978-3-642-45103-4_25

Fortuna, M. H., Werner, C. M. L., & Borges, M. R. S. (2008). Info cases: Integrating use cases and domain models. Proceedings of the 16th IEEE International Requirements Engineering Conference, RE'08, 81–84. https://doi.org/10.1109/RE.2008.43

González, A., España, S., Ruiz, M., & Pastor, Ó. (2011). Systematic Derivation of Class Diagrams from Communication-Oriented Business Process Models. In Lecture Notes in Business Information Processing (Vol. 214, pp. 246–260). https://doi.org/10.1007/978-3-642-21759-3_18

Gotel, O. C. Z., & Finkelstein, A. (1994). An analysis of the requirements traceability problem. Proceedings of IEEE International Conference on Requirements Engineering, 94–101. https://doi.org/10.1109/ICRE.1994.292398

Henderson, J., & Venkatraman, N. (1999). Strategic alignment: Leveraging information technology for transforming organizations. IBM Systems Journal, 38(2&3), 44. https://doi.org/10.1086/250095

Host, M., Regnell, B., & Wohlin, C. (2000). Using students as subjects - a comparative study of students and professionals in lead-time impact assessment. Empirical Software Engineering, 5(3), 201–214. https://doi.org/10.1023/A:1026586415054

Juristo, N., & Moreno, A. M. (2001). Basics of Software Engineering Experimentation. Analysis (Vol. 5/6). Springer. https://doi.org/10.1007/978-1-4757-3304-4

Kock Jr, N. F., & McQueen, R. J. (1996). Product flow, breadth and complexity of business processes. Business Process Re-Engineering & Management Journal, 2(2), 8–22. https://doi.org/10.1108/14637159610148040

Lindland, O. I., Sindrie, G., & Solvberg, A. (1994). Understanding Quality in Conceptual Modeling. IEEE Software, 11(3), 42–49.

Lucia, A. De, Fasano, F., Oliveto, R., & Tortora, G. (2007). Recovering traceability links in software artifact management systems using information retrieval methods. ACM Transactions on Software Engineering and Methodology, 16(4), 13-es. https://doi.org/10.1145/1276933.1276934

Moody, D. L. (2003). The Method Evaluation Model : A Theoretical Model for Validating Information Systems Design Methods. Information Systems Journal, 1327–1336. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.108.3682&rep=rep1&type=pdf

OMG (Object Management Group). (2015). BPMN Specification - Business Process Model and Notation. Bpmn.Org Website. Retrieved from http://www.bpmn.org/

Panach, J. I., España, S., Dieste, Ó., Pastor, Ó., & Juristo, N. (2015). In search of evidence for model-driven development claims: An experiment on quality, effort, productivity and satisfaction. Information and Software Technology, 62(1), 164–186. https://doi.org/10.1016/j.infsof.2015.02.012

Peltz, C. (2003). Web services orchestration and choreography. Computer, 36(10), 46–52. https://doi.org/10.1109/MC.2003.1236471

Shin, J. E., Sutcliffe, A. G., & Gregoriades, A. (2005). Scenario advisor tool for requirements engineering. Requirements Engineering, 10(2), 132–145. https://doi.org/10.1007/s00766-004-0207-3

van der Aalst, W. M. P. (2013a). Business Process Management: A Comprehensive Survey. ISRN Software Engineering, 2013, 1–37. https://doi.org/10.1155/2013/507984

van der Aalst, W. M. P. (2013b). Business Process Management: A Comprehensive Survey. ISRN Software Engineering, 2013, 1–37. https://doi.org/10.1155/2013/507984

van der Aalst, W. M. P., ter Hofstede, A., Weijters, A. J. M. M., & Weske, M. (2003). Business process management: A survey. In Business Process Management (pp. 1–12). https://doi.org/10.1007/3-540-44895-0_1

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., & Wesslén, A. (2012). Experimentation in software engineering. Experimentation in Software Engineering, 9783642290, 1–236. https://doi.org/10.1007/978-3-642-29044-2

Xu, L. Da. (2011). Enterprise systems: State-of-the-art and future trends. IEEE Transactions on Industrial Informatics, 7(4), 630–640. https://doi.org/10.1109/TII.2011.2167156