Laboratory Package (LP) template

**Core modules**

1. Introduction to the LP module

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| **Section** | **Content** |
| *1. 1 LP objective and uses* | Objectives of the LP as an instrument, detailing its possible uses outside experimental research. |
| *1.2 Experimental theory* | Definitions of the concepts of experimental research required to understand the document. |
| *1.3 Document organization* | Description of the structure of the document, specifying the objective of each section of the LP for ease of use and extensibility. |
| *1.4 Communication instances* | Alternative or complementary instruments of communication apart from the LP that can be used to perform a replication or are recommended for use. |
| *1.5 Contact information* | Contact information of the original authors of the LP, property rights and restrictions on use. |

1. Theory module

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| **Section** | **Content** |
| *2.1 General paradigm* | General theory underlying the experiment, specifying the assumptions of the theory. |
| *2.2 Description of techniques* | Description of the software engineering techniques studied in the experiment. The description should be as detailed as possible, even if it describes variants that can be applied. It includes references to the most important literature on techniques. |
| *2.3 Known relationships* | One or more conceptual models to explain the relationships between the studied software engineering elements. They may represent casual relationships, formulae or diagrams. |
| *2.4 Study aspects* | Unconfirmed aspects that are currently under research related to the techniques studied by the experiment, explaining the general research hypotheses that are being explored and detailing aspects about which primary evidence or contradictory findings already exist. |
| *2.5 References* | Literature references listed in a standard format. The references may concern the theory, the examined software engineering technique, related experimental studies, or publications forming part of the family of experiments. |

1. Training module

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| **Section** | **Content** |
| *3.1 Training guidelines* | General instructions for training subjects, including the target knowledge level. |
| *3.2 Theoretical presentations* | Theoretical presentations for use in the training classes. As sometimes only parts of these presentations may be used, they must be as detailed and flexible as possible. In this manner, the training can be adapted to subjects with different levels of expertise. Another point to be taken into account is that some of the techniques may not be applied in the replication. The explanations in the theoretical material should have as few dependencies as possible. |
| *3.3 Practice exercises* | Examples and exercises to practice the application of the techniques for which training is being given. The examples target both the experimental subjects and the replicating experimenters. Replicating experimenters can use them to verify their correctness criteria and get acquainted with the techniques from the operational viewpoint. |
| *3.4 Correctness criteria* | Description of the correctness criterion to be used to evaluate whether a technique was correctly applied and to what extent. This supplements the examples, but may contain specific instructions for the replication corrector. |
| *3.5 Feedback session* | Theoretical material for the feedback session with subjects. It includes: an introduction specifying experiment objectives, defect analysis or sample programs, and a template for discussing preliminary results. |

1. Experiment module

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| **Section** | **Subsection** | **Content** |
| ***4.1 Planning*** | *4.1.1 List of replication activities* | Each activity required to perform the replication must have a description, specifying the dependency and order of the activities for the replicating experimenter. |
| *4.1.2 Estimated workload* | The estimated workload for the replicating experimenter stated in person-hours or person-weeks. The workload estimation may be broken down by replication activity, also specifying the institutional and material resources required for a replication. |
| *4.1.3 General schedule* | The schedule includes the activities to be carried out, illustrating the sequence and simultaneity of activities within a time framework. The schedule is useful for highlighting activity peaks and assigning specific dates to replication tasks. |
| ***4.2 Study conception*** | *4.2.1 Objectives* | Description of the high-level attributes that are studied by the experiment and its goals. |
| *4.2.2 Hypotheses and substudies* | The hypotheses should be defined using the null/alternative hypothesis format for each of the defined substudies. |
| *4.2.3 Factors and response variables* | The factors are all the elements that are modified in each experiment treatment group. Different response variables can be taken into account for each substudy, each depending on a particular measurement approach. |
| *4.2.4 Contextual variables* | Parameters of the experiment that are fixed throughout the different treatments. They are the elements that influence the phenomenon and should be controlled. |
| ***4.3 Experimental design*** | *4.3.1 Design alternatives* | List of design alternatives for the experiment. The alternatives can include experimental designs already used in earlier replications which are potentially valid bearing in mind the study conception. They should include a reference to the theory of experimentation used as a basis for the design. |
| *4.3.2 Guidelines for selecting the experimental design* | They describe the relationship between the potential design alternatives and the site constraints; for example, which alternatives will reduce experimentation times or resource requirements. |
| *4.3.3 Validation of the experimental design* | Instructions for validating the specified experimental design according to the theory of experimentation. In order to avoid replication errors, they include basic experimental design concepts; for example, verification of necessary factor crosses or control groups. The validation should not be so strict as to discourage the use of new experimental designs. |
| ***4.4 Operation*** | *4.4.1 Instructions for preparing material* | Steps necessary for preparing the material for the sessions. This may involve printing out forms or setting up a laboratory environment. They must specify what steps the replicating experimenter can take to improve the management of the volumes of material and assure the correct application of the experimental design. They should include a checklist of deliverables which may vary depending on the treatment. |
| *4.4.2 Operating material* | The operating material includes the objects with which the experimental subjects come into direct contact. They include specified software engineering objects (like programs, specifications or test cases) and instruments used for measurement and support (such as data collection forms or tools). There may be alternative objects and different versions; for example, several program specifications, implementations of one and the same program in different programming languages, different sets of seeded faults. It is a good idea for the replicating experimenter to have alternative objects in order to adapt the experiment to the site. |
| *4.4.3 Instructions for running sessions* | If the experiment is run live with the subjects, the replicating experimenter should be given instructions as to how to manage the session. Session management may include giving verbal instructions to subjects to round out written instructions, describing the operational environment and dealing with questions asked by subjects and any other incidents arising during the session. |
| ***4.5 Analysis*** | *4.5.1 Data collection* | This section specifies the data collection method and any changes necessary to output the response variables. In some cases, several measurements may have to be taken to gather a response variable. All units and transformations must be specified. The final data are collected using standard templates with data fields for each factor and response variable. A spreadsheet template or similar should be included to make the replications easier to compare. |
| *4.5.2 Analysis methods* | The applied analysis methods will depend on the experimental design used. They should specify the suggested statistical methods in order to analyse data. They may or may not be parametric and be divided into several compulsory and optional steps. Each method must contain a reference to a formal and accepted definition. Each method may include an analysis of its validity threats and application conditions. |
| *4.5.3 Results interpretation* | The experiment report must conclude with a high-level interpretation of the results. Having applied the analysis methods, the replicating experimenter will require guidance to identify any significant interactions. This section specifies how to interpret the results of the statistical analysis method with regard to the studied software engineering technique. |

1. Evolution module

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| **Section** | **Content** |
| *5.1 Experiment log* | Summary of the evolution of the experiment, explaining the major stages through which the experiment has passed in the course of the experimental research cycle. |
| *5.2 List of replications* | This section includes a list of replications, including for each one a summary and a reference to the detailed description that can be found in the Replication Module. Each replication must match up with to a particular version of the experiment. |
| *5.3 List of aggregations* | This section includes a list of aggregations carried out using the data from the replications within the family of experiments. Each aggregation includes a summary and a reference to the detailed description that is to be found in the Aggregation Module. |

**Study modules (several instances)**

1. Replication modules

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| **Section** | **Detail** |
| *6.n.1 Description of the replication* | This section describes all the aspects of the conducted replication; for example, the date of the replication, site, replicating experimenters, design used, etc. It also has space for the replicating experimenter to write general unstructured comments and notes. The template for this section is shown in the following table with more detail. |
| *6.n.2 Raw data* | Spreadsheet containing all the raw data of the replication in a standard format. It should enable other researchers to repeat the entire results analysis process. |
| *6.n.3 Results interpretation* | Synthesized results of the replication, where the replicating experimenters write their interpretations.  This includes the references to external publications on the replication.  It also includes the lessons learned and changes suggested for the experiment and the LP. |

6.n.1 Description of the replication. (The replicating experimenter has to fill in the grey cells.)

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| **Site and replicating experimenter** | |
| *Institution* |  |
| *Date* |  |
| *Principal replicating experimenter* |  |
| *Other participating researchers* |  |
| *Motivation of replication* |  |
| *Communication with other groups* |  |
| **Conception and design** | |
| *Conducted substudies* |  |
| *Experimental design used* |  |
| *Number of participating subjects* |  |
| *Number of subgroups* |  |
| *Site constraints* |  |
| *Contextual variables* |  |
| **Population characteristics** | |
| *Degree or course* |  |
| *Subject name* |  |
| *Subject syllabus* |  |
| *Subject background* |  |
| *Motivation for completing assigned exercise* |  |
| *Hours of training* |  |
| *Training material used* |  |
| **Operation** | |
| *Session organization (date, place, treatments)* |  |
| *Description of the environment* |  |
| *Incidents and notes on operation* |  |
| *Total replication effort* |  |

1. Aggregation modules

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| **Section** | **Content** |
| *7.n.1 Protocol* | Protocol or summarized protocol used for the systematic review, specifying, for example, how the replications were selected, what the research question is, who conducted the aggregation. |
| *7.n.2 Replications included* | Pointers to the replications included in the aggregation. If they are not included in the LP, an external reference will be required. |
| *7.n.3 Data extraction* | Reporting of all the data extracted from each study in a standard format. |
| *7.n.4 Results aggregation* | Synthesized results of the aggregation. The research states the conclusions, including references to external publications on the aggregation. |