UML Activity Diagrams, are widely used. Recently, *declarative* approaches have received increased interest and suggest a fundamentally different way of describing business processes [13]. While imperative models specify exactly how things have to be done, declarative approaches only focus on the logic that governs the interplay of actions in the process by describing (1) the activities that can be performed, as well as (2) constraints prohibiting undesired behavior. An example of a constraint in a travel process would be that between a `Diving` activity and a `Flightseeing` activity there must be a resting period of two days to prevent aeroembolism. Imperative models take an 'inside-out' approach by requiring all execution alternatives to be explicitly specified in the model. Declarative models, in turn, take an 'outside-in' approach: constraints implicitly specify execution alternatives, as all valid alternatives have to satisfy the constraints [14]. Adding more constraints means discarding some execution alternatives (cf. Fig. 1). This results in a coarse up-front specification of a process, which can then be refined iteratively during run-time. Typical constraints described in literature can be roughly divided into three classes (e.g., [7, 13]): constraints restricting the *selection* of activities (e.g., the minimum or maximum occurrence of activities, mutual exclusion, co-requisite), the *ordering* of activities (e.g., pre-requisite or response constraints) and the use of *resources* (e.g., execution time of activities, time difference between activities, budget, etc.).

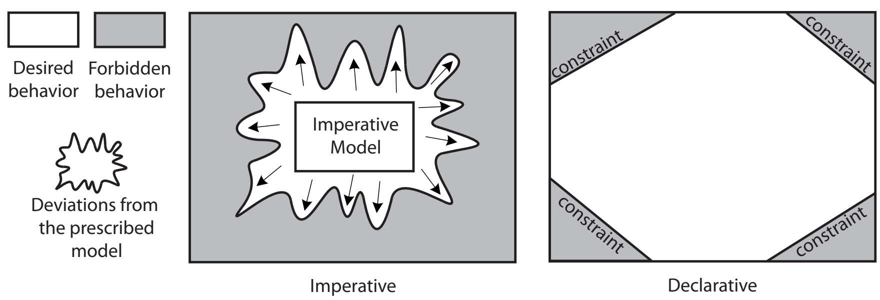

Fig. 1. Imperative vs. Declarative Approaches to Process Modeling (adapted from [14])

2.2 The Alaska Simulator

The Alaska Simulator[1] [15] fosters the comparison of different approaches to process flexibility, e.g., declarative processes, by using a *journey* as metaphor for a *business process*. The similarities being exploited here are that regardless of whether a journey or a business process is executed, various steps must be planned and carried out, even if the actual execution of those steps may be different from what is initially foreseen. Furthermore, journey planning is an attractive context for many people to become engaged in, which highly improves their willingness to participate in experiments.

The actions of a journey, like travel activities, routes and overnight stays correspond to activities in the business process. When conducting a journey, the

[1] Developed at the University of Innsbruck, http://www.alaskasimulator.org

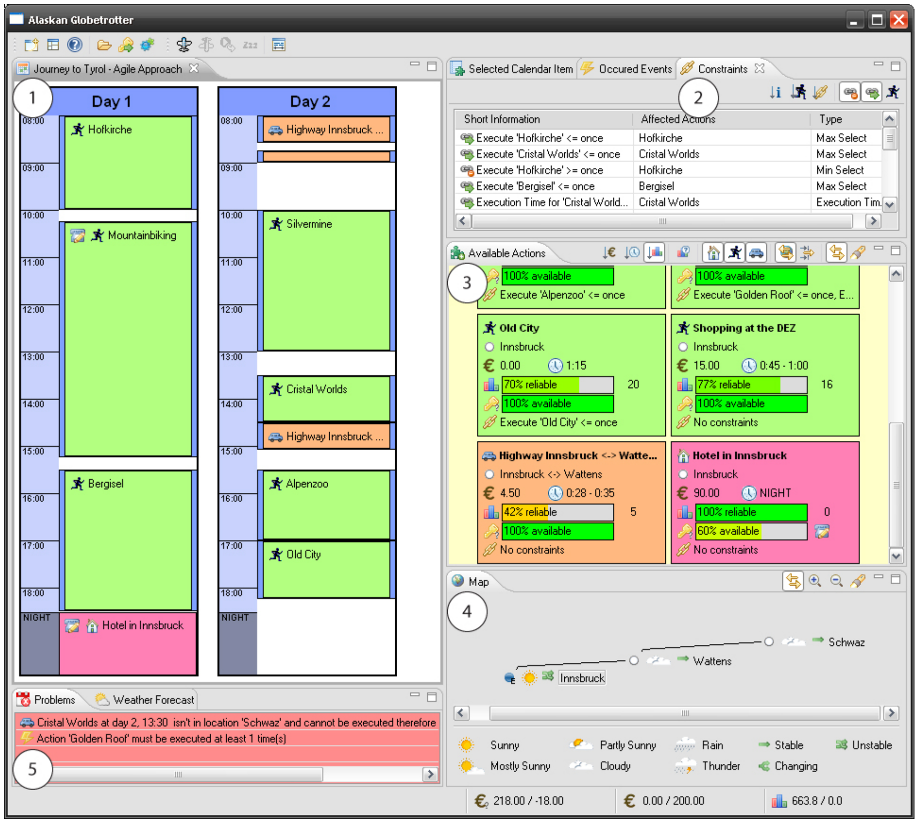

Fig. 2. Screenshot of the Alaska Simulator

3.1 Experimental Setup

Subjects: We conducted the experiment with 20 students of the study program “Management, Communication & IT” at the Management Center Innsbruck.

Objects: Two journeys representing two different business processes are used as objects, subsequently referred to as Configuration California (ConfCA) and Configuration Alaska (ConfAK). The configurations define the journey settings, like actions to be executed, constraints restricting their execution, events that might occur during run-time and weather conditions (cf. Section 2). For each of the configurations, two variants are created: A and B, differing in the number of events only. While Variant A contains no events, Variant B comprises many unforeseen events (e.g., event increasing the action’s duration, temporary road closure). An overview of the different variant characteristics is given in Fig. 3.

Factor and Factor Levels: The number of unforeseen events that occur during run-time is the considered factor with levels “no events” and “many events”. Variant A of a configuration corresponds to factor level “no events” and variant B to factor level “many events”.

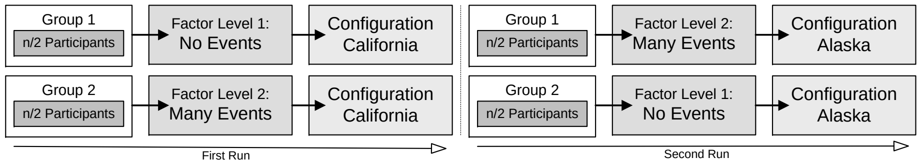

Fig. 4. Employed Experimental Design

3.3 Risk Analysis and Mitigation

In this section risks threatening the validity of the experiment are discussed.

Individual Planning Experience: Differences of participating students in respect to planning experience and productivity might have an impact on the students' performance, i.e., the business value achieved. This issue can be balanced by conducting the experiment with a sufficiently large and representative set of students or by replicating the experiment. The relatively low number of subjects (19 out of 20 could be used for data analysis) certainly constitutes a threat to the validity of this experiment.

Suitability of Metaphor: Whether or not the results of this experiment can be generalized to business process modeling and execution highly depends on the suitability of the chosen metaphor. However, due to the similarities of business process modeling and traveling planning and their respective execution (cf. Section 2), we assume the suitability of the metaphor. To further increase confidence in our view we plan testing whether travel planning serves as a good proxy for business process modeling and execution in future experiments.

Students instead of Professionals: In our experiment undergraduate students with limited planning experience were the subjects for investigating how well inexperienced users are able to model and execute declarative processes with varying numbers of events. While students can be regarded as suitable proxies for inexperienced users [17], it is arguable whether the results of this experiment can be generalized to professionals with significant planning experience. When replicating the experiment with experienced professionals we expect them to clearly obtain better process outcomes (i.e., higher business value and lower number of failed journeys).

Choice of Object: To be able to generalize results gained from this experiment, the configurations must be representative for a wide range of business process settings. Although the configurations used in this experiment do not have the complexity of real-world processes, they range well beyond the size of toy examples and include 22 and 26 activities, each of them varying in terms of expected business value, reliability and availability as well as their constraints and events.

Team Planning: In our experiment planning and execution was done on an individual basis, not in teams. Since planning often involves interactions among domain experts, system analysts and stakeholders, it has to be investigated how far our results can be transferred to team planning. For this we plan to replicate the experiment in a team setting.

to Variant B (many events). The question is whether the observed differences in mean business values and number of failed journeys are statistically significant.
Data Plausibility: Fig. 6 shows a *box-whisker-plot diagram* as used for analyzing data plausibility. It visualizes data distribution and detects outliers. For ConfAK (many events) a single outlier exists. Since this is the only outlier, plausible data distributions seem to be in effect.

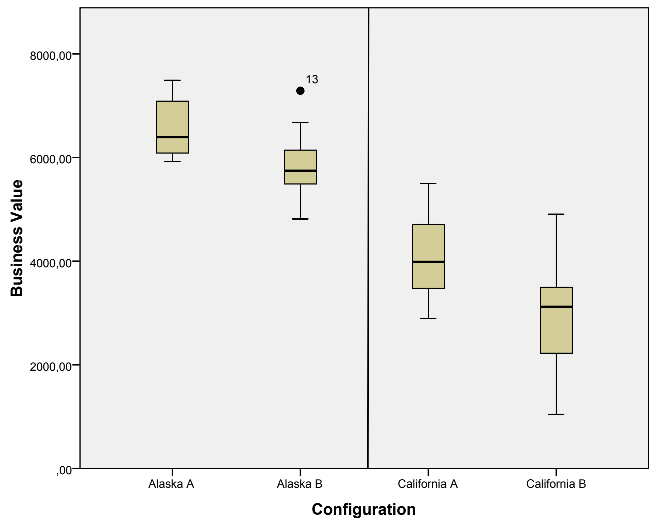

Fig. 6. Data Distribution (Box-Whisker-Plot Diagram)

Testing for Differences in Business Value: Since the expected business values of ConfAK and ConfCA differ, hypothesis testing is performed for each configuration separately. For ConfCA preconditions for the t-test for homogeneous variances are fulfilled (i.e., data is normally distributed and the Levene test confirmed equal variances). With an obtained significance of 0.013 (< 0.05) hypothesis $H_{0,0}$ can be rejected at a confidence level of 95%. ConfAK also fulfills all prerequisites for the t-test for homogeneous variances. The resulting significance of 0.030 (< 0.05) also leads to a rejection of hypothesis $H_{0,0}$ at a confidence level of 95%.
Testing for Differences in Number of Failed Journeys: To test for differences in the number of failed journeys we used Fisher's exact test [18]; the Chi Square test was not applicable due to the small sample size. For ConfCA, with an obtained significance of 0.017 (< 0.05) hypothesis $H_{1,0}$ can be rejected at a confidence level of 95%. For ConfAK, in turn, the obtained p-value of 0.054 (> 0.05) is slightly above the cut-off point. Consequently, hypothesis $H_{1,0}$ cannot be rejected for ConfAK.

4.3 Discussion of Results

The major finding from our data analysis is that unforeseen events have a statistically significant impact on the outcome of journeys. Furthermore, the results

respect to PAISs mainly deal with establishing their contribution to business performance improvement, e.g. [26, 27], and the way end-users appreciate such technologies, e.g., [28, 29].

6 Summary and Outlook

The advantages attributed to declarative processes are manifold, e.g., support for partial workflows allowing users to defer decisions to run-time, the absence of over-specification as well as more room for end-users to maneuver. However, their practical application requires the ability to resolve uncertainty and exploit learning outcomes. This raises the question whether inexperienced users are able to execute declarative processes especially when unforeseen events occur during run-time. This work picks up on this demand and contributes a controlled experiment comparing the process outcome for inexperienced users depending on the number of events.

While previous work shows that end-users can effectively handle varying levels of constraints when executing a declarative process, this paper demonstrates that unforeseen events are more problematic. The major result of our experiment is that process outcomes of inexperienced planners are significantly affected by unforeseen events which have to be handled during run-time. In particular, the combination of constraints and events turned out to be challenging for our subjects. These findings support the argument that declarative approaches require experienced users to fully exploit its benefits.

For further research we aim to investigate different techniques for improving understandability and maintainability of declarative process models to facilitate their application by less experienced users. Furthermore, we plan to run experiments in settings where planning is done in small teams, not individually, and replicate the experiment with more experienced users.

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