Fuzzy and CMMN Based Dynamic Software Project Management Process Modelling and Simulation

Šarūnė Sielskaitė[1], Diana Kalibatienė[2]
Department of Information Systems, Faculty of Fundamental Sciences, Vilnius Gediminas Technical University, [1]sarune.sielskaite@vilniustech.lt, [2] diana.kalibatiene@vilniustech.lt

VILNIUS TECH
Vilniaus Gedimino technikos universitetas

ABSTRACT

- The Project Management Institution [1] defined *project management* as the use of specific knowledge, skills, tools, and techniques to deliver a value to the people. However, the needs of those people are growing, so naturally, software projects are getting more complex and challenging to be implemented.
- We propose a new approach for choosing and adopting a software development process to a particular context using its fuzzy and CMMN based modelling and simulation.
  - In this approach, we are looking at software project management as a dynamic business process, a complex knowledge-based process embedded in a performance process (e.g., developing software, product development, and so on) that could be modelled and simulated to analyse its changes.
  - Case Management Model and Notation (CMMN) is suitable for adaptive case management and decision making by suggesting and keeping people in the manager position.
  - Since software development process is fuzzy by its nature (i.e., resources, finance budget, course of tasks change), a fuzzy theory seems to be helpful to model those uncertainties.

BACKGROUND

- **Software development process** – is a process of developing a software product, which in general includes most development processes and uses the following activities: requirement gathering, design, implementation, testing, and maintenance.
- A **dynamic business process** (DBP) is a process that supports structural and functional changes (i.e., has no predefined activities nor sequence of activities) at DBP instance run-time, according to its context and rules, and that can be implemented with minimal delay [2].
- **Case Management Model and Notation** (CMMN) is known for its adaptive case management, which assists in decision-making by making suggestions and keeping people in the manager's position. Case management is more about knowledge workers to give them a power and all the information regarding case to control on how a case runs [3].
- A **fuzzy set** A is a set whose elements have degrees of membership [4]:

$$A = \{u, \mu_A(u) | u \in U, \mu_A \colon U \to [0; 1]\}$$

where A in the universe of discourse U and, $\mu_A(u)$ is MF of u in A. The value $\mu_A(u)$ represents the grade of membership of u in A and is interpreted as the membership degree to which u belongs to A.

MAIN ISSUES

- Most of the existing traditional statistical and mathematical models (like regression and interpolation) are not suitable to predict time and resources necessary for successful software development process, since it is complex, nonlinear, human-dependent and vague.
- Based on the related works, the main uncertainties affecting the dynamism of software development process are as follows:
  - the behavior of process resources
  - changing conditions
  - the course of activities.
- The behavior of process resources is mainly concerned with human factor, competences of resources, psychological aspects.

METHODS

- For a software development process (SDP) simulation, a CMMN is used to model all the tasks relevant to SDP and tasks distributed according to SDP.
- The developed CMMN model for SDP simulation consists of:
  - Input parameters (tasks, agents, agents-roles-task matrix)
  - The simulation consists of three separate modules: simulation scenario specification module, simulation scenario execution module, report generation module.
  - Output: actual time for tasks performance, responsible agent.
- Using the proposed CMMN model, the SDP modelling and simulation is performed at the initial stage of SDP, when user's needs are defined.

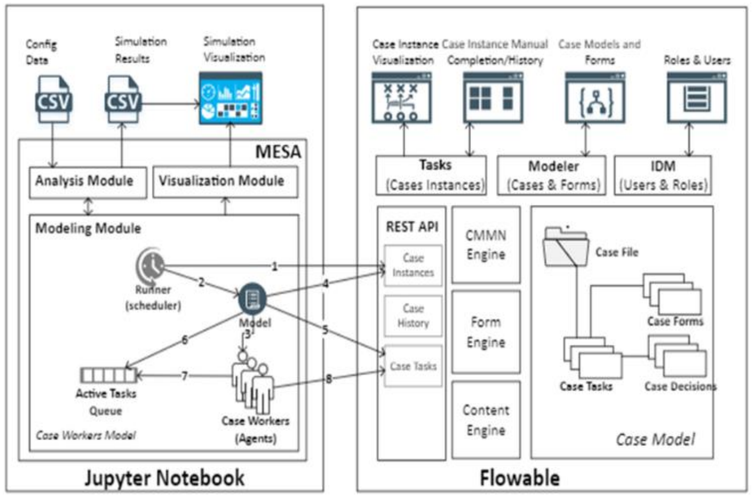


Figure 1. The architecture of ~~a~~ simulation model for project management

- The proposed model was implemented into the prototype using ~~the~~ Python programming language and Mesa plugin. Mesa is used to simulate the developed CMMN model. For the proposed CMMN model implementation, we have used Flowable.
- Requests from Mesa to Flowable REST API are sent to get input data, which defines a sequence of project activities, their duration, and constraints in (.csv) format.
- The output data is saved in the electronic spreadsheet tool format (.csv) and uniquely generated during each simulation.

RESULTS

- All the agents involved in the simulation are brought together and have assigned roles, according to which SDP tasks can be assigned.
  - To successfully complete SDP simulation, it is necessary to have all the roles, as not performing a particular task does not allow to complete the whole case simulation.
- During the experimental study various parameters related to the SDP can be calculated according to four aspects-as follows:
  1. Non-prioritized tasks / resources for all roles by one.
  2. Non-prioritized tasks / resources for all roles by two.
  3. Prioritized tasks / resources for all roles by one.
  4. Prioritize tasks / resources for all roles by two

RESULTS

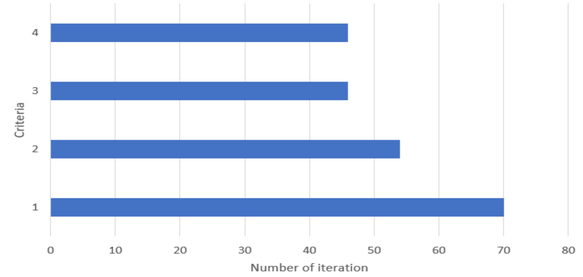
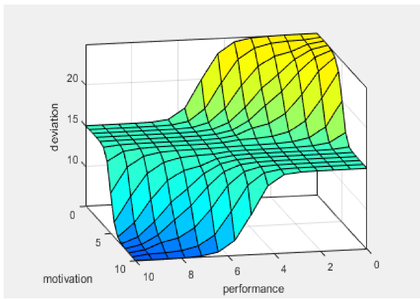


Figure 2. Number of iterations

- The obtained results showed that the least iterations occur when the SDP tasks are prioritized. In this case, agents primarily perform only the most important tasks, thus moving to less important ones and those whose performance do not affect the performance of other tasks.
- To be more accurate while predicting human factor in SDP simulation, we added fuzzy variables: motivation and performance.

PERFORMANCE	Value	MOTIVATION	Value	DEVIATION FROM ESTIMATION (%)	Results
High	10	High	10	0	Not exceeded
Medium	5	Medium	5	15	Medium exceeded
Low	0	Low	0	30	Highly exceeded

Table 1. Motivation, performance and deviation values



Described main rules:

- (performance==low) & (motivation==low) => (deviation=highly_exceeded) (1)
- (performance==medium) &(motivation==medium) => (deviation=medium_exceeded) (1)
- (performance==high) & (motivation==high) => (deviation=not_exceeded) (1)

Figure 3. Motivation and performance impact to deviation from original estimation time

REFERENCES

1. Singh, H., & Williams, P. S. (2021). A Guide to the Project Management Body of Knowledge: PMBOK (®) Guide. Project Management Institute.
2. Kalibatiene, D., & Vasilecas, O. (2021). A survey on modeling dynamic business processes. *PeerJ Computer Science*, 7, e609.
3. Marin, M. A. (2016). Introduction to the case management model and notation (CMMN). arXiv preprint arXiv:1608.05011.
4. Zadeh, L.A. (1965). Fuzzy sets. *Information and control*, 8(3), 338–353.