of the monitoring variable is employed as a value of the control limits. Alpha, say 90% or 95%, reflects the risk tolerance of the PM. This approach may work well pragmatically, although it has two main drawbacks. First, each activity contributes differently to the project duration. Hence, instead of using an identical percentile, the PM should consider each individual activity's relative importance to the project. Second, the conventional approach lacks a cost perspective. Since the control limits affect the cost of corrective actions, the PM should evaluate their impact on the total budget to determine the control limits. These points of view suggest a new approach within which the control limits can be optimized with respect to both cost and schedule. In this presentation, we will propose an integral framework to select the optimal control limits as well as the optimal resource allocation. The model is formulated as a two-stage stochastic programming problem that includes decision variables corresponding to activities' control limits in the first stage. We will also discuss heuristic approaches to simplify the computational process.

4 - Analysis of the Polynomial Complexity of a Classic Algorithm for a Project Scheduling Problem with the Maximization of the Net Present Value

Isac Mendes Lacerda, Jayme Szwarcfiter, Eber A. Schmitz, Rosiane deFreitas

Among the project scheduling problems is the maximization of Net Present Value (NPV) without resources constrained, with finish-start precedence and 0-lag between activities. For this problem, Demeulemeester and Herroelen (2002) proposed an algorithm organized in three steps. In the first step, a tree called Early Tree (ET) is created with as soon as possible scheduling for each activity, respecting the precedences (memorized in a graph). In the second, it generates a copy of the ET, called Current Tree (CT) to identify negative activities without successors are identified. In the third, the algorithm identifies and postpones sets of activities that can increase NPV. To do this, it dynamically creates and deletes precedences in the CT. The first and second steps happen in O(n2) time complexity, given by the authors. However, the third and most important step was considered an open question. Thus, in this work, we present the analysis of the computational complexity to this algorithm, where the worst case occurs in an arrangement with sequential activities, where requires the maximum of disconnections and connections of activities. This condition and step also configures an O(n2) time complexity. Such characterization confirms the robustness of the solution proposed by the authors, as well as contributes to other related algorithms and work researches. Ref.: Demeulemeester E., Herroelen W. 2002. Int.Series. Project scheduling — A research handbook. Boston: K. Academic.

∎ TA-38

Tuesday, 8:30-10:00 - Q012

Decision Aiding Methods 2

Stream: Multiple Criteria Decision Aid
Invited session
Chair: *Maria Cerreta*

1 - Risk analysis and management for urban planning decisions: a decision aid perspective

Francesca Torrieri, Alessandra Oppio, Marta DellOvo, Emanuele DellOca

Urban developments are complex processes characterized by the presence of several actors willing to act with the aim of optimal levels of both return and risk. The trade-off between risk and profit represents a key factor in investment decisions, even more in the case of urban developments characterized by public-private partnerships and long-term horizons. Two different perspectives on risk management, a traditional engineering and a behavioural perspective. The behavioural perspective seems very promising to get more insight in the actual risk

behaviour of developers, but an adequate framework is lacking. Considering these premises, the work will be focused on the relation between profit and risk in urban development projects under the perspective of finding a balanced allocation of risks. For this purpose, we have proposed a multidimensional and multistakeholder approach for risk analysis and management. A questionnaire has been administered to a panel of expert in order to rate the risk perceived by actors involved in real estate development and how it changes according to the role they play in each stage of the process.

2 - Evaluating the environmental quality of a territorial system taking into account interaction of criteria through the Choquet integral preference model

Marta Bottero, Chiara D'Alpaos, José Rui Figueira, Salvatore Greco

Environmental quality is a complex multi-faceted concept which refers to a set of environmental characteristics and properties. In order to measure it several variables and indicators have to be taken into account: air pollution, waste management, soil consumption, acoustic emissions, etc. Moreover, the natural dynamics of land-use territorial systems are often characterized by interactions among environmental and ecological components, thus requiring the adoption of specific valuation approaches. This paper presents an application of the Choquet multiple criteria preference aggregation model proposed by Bottero et al. (2018) for measuring the environmental quality of a set of 20 municipalities located in a semi-rural area in Piedmont Region (Italy). According to Bottero et al. (2018), in order to apply the Choquet integral approach to a real world decision problem, two procedures will be implemented: the first is used to assign utility values on a common scale to criteria performances, and the second to assign numerical values to the capacities of the Choquet integral. In detail, we provide a scoring of the municipalities under investigation based on a set of multidimensional indicators that can be useful in the assessment of overall environmental conditions and in supporting strategic planning decisions. To structure the valuation model we organized focus group with multidisciplinary experts in landscape planning and management, ecology and socio-economic systems.

3 - An integrated decision support tool to evaluate retrofit scenarios at district scale

Federico Dell'Anna, Cristina Becchio, Marta Bottero, Stefano Corgnati, Giulia Pederiva, Giulia Vergerio

In recent years, a new sustainable view of urban settlement is rising. Indeed, the European Commission defines the post-carbon city as characterized by buildings consuming low energy due to smart heating and cooling systems, and sustainable transport solutions based on the use of private electric and hybrid vehicles. In this context, new parameters come into play with the aim of identifying the best design profile to respond to new energy, environmental and market policies. In accordance with the European Directive, the tool used when evaluating public projects and policies is the Cost Benefits Analysis (CBA). It has been highlighted that one of the main limitations of the CBA method is the estimation of all positive and negative externalities in monetary value. To overcome this obstacle, a growing scientific literature on the application of Multi-Criteria Analyses (MCA) in the context of energy investments is emerging. In this work, the COSIMA (COmpoCIte Modelling Assessment) model (Barford et al., 2011), that combines the CBA and MCA methods, is proposed for ranking alternative retrofit scenarios for a district located in Turin (Italy). The integrated evaluation extends the conventional CBA into a more comprehensive evaluation, including decision criteria that would otherwise not be considered. A panel of actors has been involved to weight the effects and experts in energy have been consulted for discussing and validating the results.

4 - Assessing Urban Vulnerability: The potentials of Multi-Criteria Spatial Decision Support Systems

Maria Cerreta, Chiara Mazzarella, Giuliano Poli, Stefania Regalbuto

The contribution aims at structuring Spatial Decision Support System (SDSS) for vulnerability analysis of complex urban systems through