PROJECT MANAGEMENT
CENTER FOR EXCELLENCE
A.J. CLARK SCHOOL OF ENGINEERING
Civil & Environmental Engineering Department

APPLYING CHOOSING-BY-ADVANTAGE FOR SELECTING SCHEDULING TECHNIQUE IN ELEVATED URBAN HIGHWAY PROJECTS

Charles Igwe

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Introduction

- The need for new and reconstructed highways is an important consideration for many nations of the world.
- Transportation developments are shifting from the construction of new highways to the demolition and reconstruction of exiting facilities.
- Current practice in the construction industry suggests that there is typically budget overrun and schedule slippages associated with urban highway projects

- To counter these challenges, considerable amount of time is required to ensure that the level of development (LOD) of the plan can accommodate micro-scheduling of short duration activities.

- Selecting the project scheduling method becomes a multi-criteria decision making problem due to the different project scheduling alternatives available to the project management team.

Literature Review

- Decision making methods influence how people make decisions. These decisions trigger actions, actions have outcomes and consequences (Suhr 1999).

- Decisions such as the planning and scheduling method to adopt in construction projects are made usually without a formal method (Arroyo 2014).

- Different multi criteria decision making methods (MCDM) are available and have been successfully applied in different fields (Arroyo 2016).

- Most applications of MCDM within the construction industry are based on Weighting Rating Calculating (WRC) and the Analytical Hierarchical Process (AHP) (Akadiri et al. 2013).

- Choosing by Advantage (CBA) is an emerging lean construction MCDM method that has been successfully applied to the Architecture, Engineering and Construction (AEC) industry.

- CBA has been used sparingly in infrastructure projects such as the construction of elevated urban highway projects.

Choosing-by-Advantage

- CBA is a decision-making system that facilitates decision-making by comparing the advantages of alternatives (Arroyo et al. 2013).

Principles of CBA

(1) Decision makers must learn and skillfully apply sound decision-making methods;
(2) Decisions must be based on the importance of the advantages;
(3) Decisions must be based on relevant facts;
(4) Different types of decisions call for different decision making methods.

Main Advantage

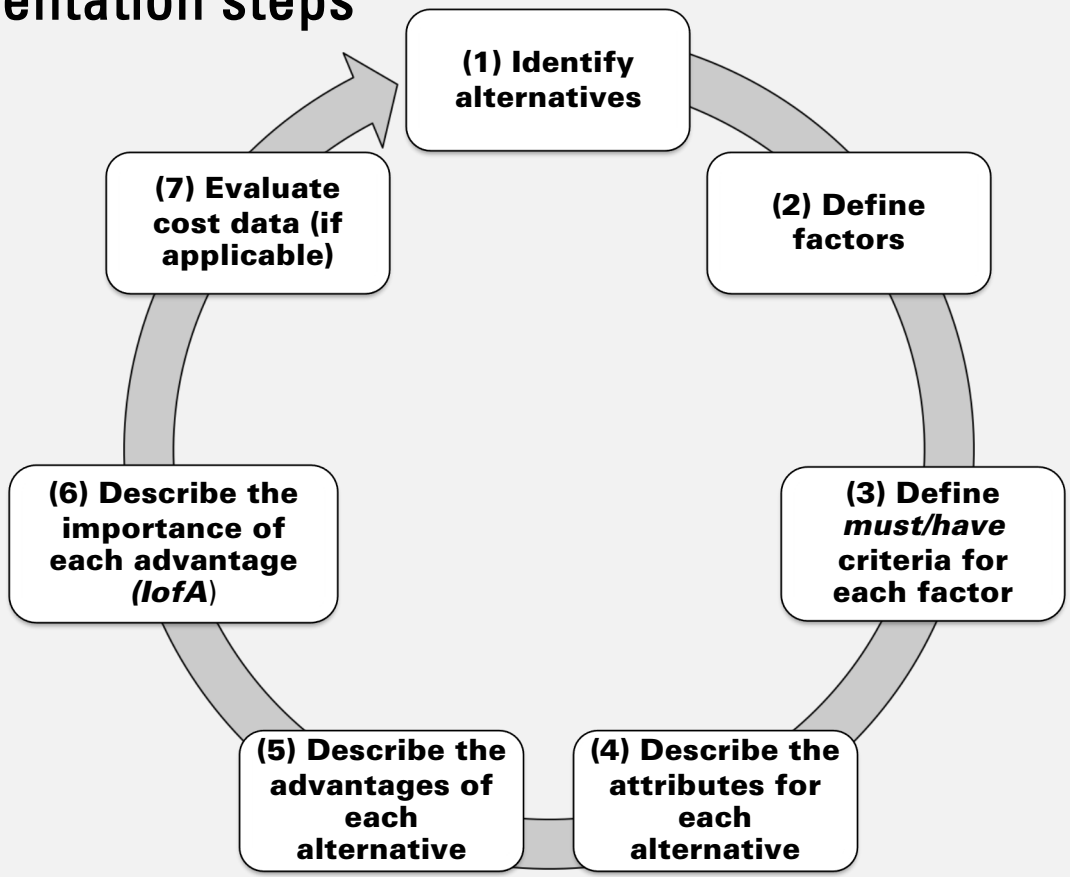
- CBA helps to differentiate between alternatives based on the decision context, reduces time to reach consensus, and manages better subjective trade-offs by basing decisions on the importance of agreed advantages (Arroyo et al. 2018).

Definition of terms for CBA analysis

Term	Definition
Alternatives	Options to be considered by the method. At least two alternatives are required for a decision to be necessary
Factor	A property of an alternative that is material to the decision. Factors can be social or environmental but do not include the cost
Criterion	"Want" criterion defines a certain value or set of values that are preferred for a factor. "Must have" criterion specifies values that a factor must have for that alternative to be considered feasible.
Attribute	Quality or characteristics belonging to one alternative.
Advantage	Difference between two alternatives when their attributes are compared

(Suhr 1999)

Implementation steps



CBA ANALYSIS: SELECTING PROJECT SCHEDULING METHOD

- 9 project managers involved in urban highway projects were selected for the CBA analysis.

- Three different planning/scheduling alternatives were identified in the literature.
    1. Critical path method (CPM)
    2. Linear scheduling method (LSM)
    3. Last planner system (LPS)

- Seven factors were jointly identified in an interactive session with the project managers that will serve as the basis for differentiating the alternatives.
- The attributes of each alternative were obtained from existing literature and validated by the project managers.
- The least desirable attribute for each identified factor is underlined and used as a comparison to describe the advantage of the alternative based on that factor.

- The advantage of each alternative was then decided by each respondent by assigning weights to the advantages based on the factors and criteria. The weights for each factor and criteria ranged from 0 to 100.

- The importance of each alternative (IofA) was then decided based on the relative weight obtained from the respondents.

STEP BY STEP CBA APPLICATION

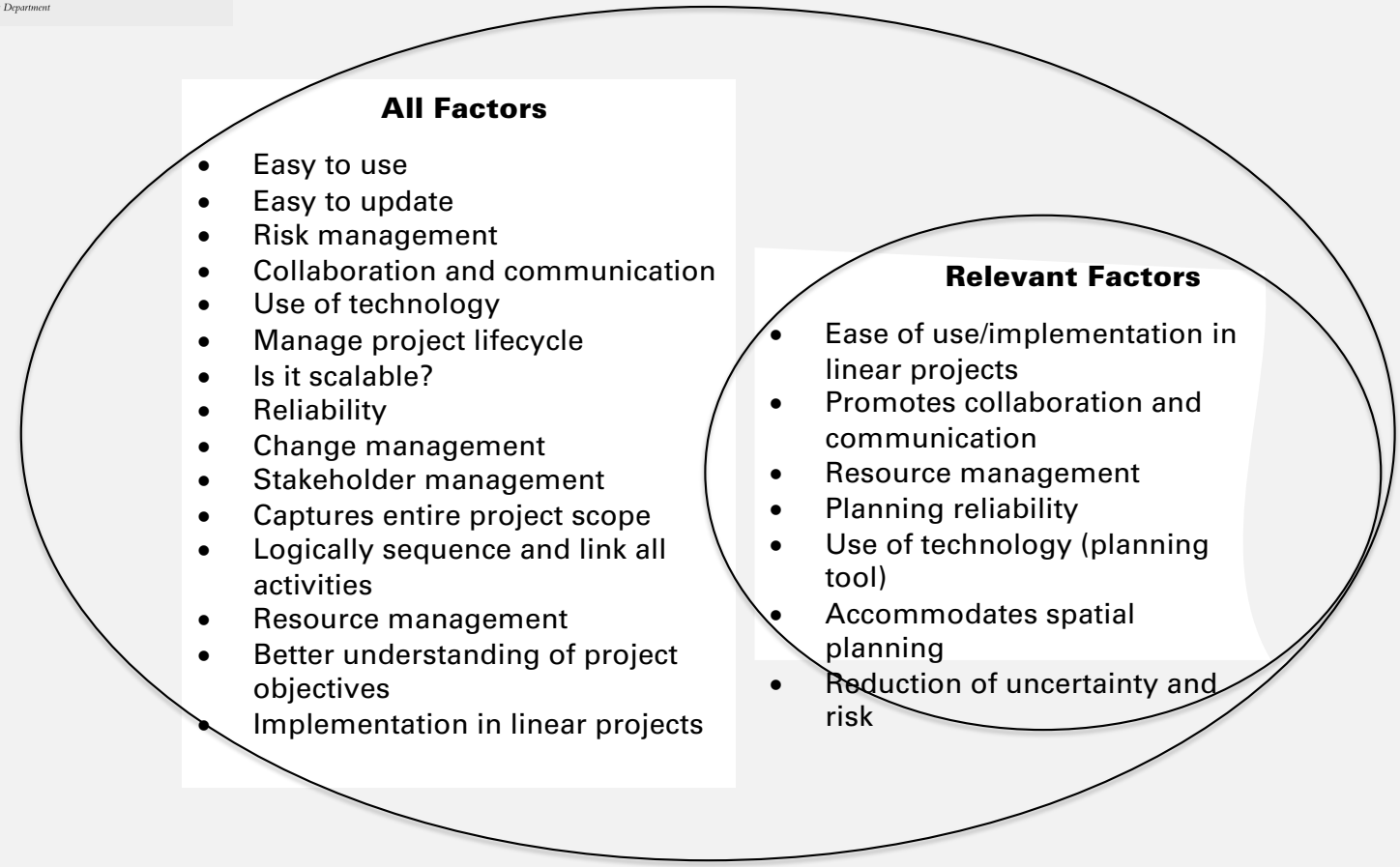
Step 1: Identify Alternatives. Three scheduling techniques were selected based on their suitability to linear projects. The alternatives considered are compared based on certain criteria.

		Alternatives		
Nos.	Factors	Last planner system	Critical path method	Linear scheduling method
1.	Reduction of uncertainty and risk	Identifies and assigns responsibility for constraints removal, facilitates reduction of risks and uncertainties.	Does not focus on identification of constraints and their removal. Makes up for this by incorporating float and slack (or modified PERT) in the schedule to account for production and duration uncertainties.	Does not tackle detailed task-level planning or identification of constraints which could have an impact on risks and uncertainties.
2.	A better understanding of project objectives	Breaking production into smaller and manageable flows ensure that project objectives are fully understood by stakeholders.	CPM networks become complicated as the size and complexity of a project increases.	Easy to use and facilitates an understanding of project objectives due to the relationship of time and space inherent in the process.
3.	Ease of use/implementation in linear projects	Easy to use. However, the absence of computer tools makes it cumbersome to apply to large work packages.	Extensive computerization has made the CPM easy to use. However, the user needs a considerable amount to produce valuable information for controlling purposes.	Very intuitive and easy to use and understand. However, limited computerization tools make it difficult to use in a large and complex project.

		Alternatives		
Nos.	Factors	Last planner system	Critical path method	Linear scheduling method
4.	Resource management	Address resource availability during the "Making-ready" process by matching workflow to capacity	Addressing key resource availability is a shortfall of this method. It focuses on calculating the theoretical early start and finish dates, late start and finish dates for all scheduled activities.	Does not explicitly consider resource management. Resource levelling is difficult as it lacks resource levelling capabilities.
5.	Collaboration and communication	A collaborative planning process that facilitates communication in the form of consultations at all stages of the project	Reduced collaboration and communication between stakeholders.	Provides a graphical display of how crews and equipment move through the project over time and therefore facilitates communication and collaboration.
6.	Space planning	The process of "making ready" focuses on the identification and removal of constraints and helps ensure that space-time relationships are considered but does not visualize them.	Does not consider time-space relationships during the planning process	Easy to visualize project schedule to account for time and space constraints. Facilitates space planning.

Step 2: Define Factors. Several factors were considered, and the relevant factors were chosen for the decision-making process.

- Factors having the same purpose were combined due to their close relationship (e.g. easy to use and implementation in linear projects). Such merging helps to avoid double counting.


All Factors
Easy to use
Easy to update
Risk management
Collaboration and communication
Use of technology
Manage project lifecycle
Is it scalable?
Reliability
Change management
Stakeholder management
Captures entire project scope
Logically sequence and link all activities
Resource management
Better understanding of project objectives
Implementation in linear projects
Relevant Factors
Ease of use/implementation in linear projects
Promotes collaboration and communication
Resource management
Planning reliability
Use of technology (planning tool)
Accommodates spatial planning
Reduction of uncertainty and risk

Step 3: Define the "must" and "want" criteria for each factor. The respondents agreed on the criteria upon which to base their decision making, and then weights were assigned collaboratively.

- For example, factor 1 considered the "ease of use/implementation in linear projects".
- The stakeholders agreed that the criterion for this factor is "Easier is better" and collectively agreed to ascribe a weight of 50 to this criterion.

Step 4: Summarize the attributes of each criterion. The main attribute of each alternative with respect to each factor is summarized.

- The least preferred attributes are summarized and underlined to highlight them.
- This provides the basis for comparison between alternatives in describing the advantages of one alternative over another.

Step 5: Decide the advantages of each alternative. The main advantage of each alternative based on a given factor and attribute is determined.

- For each factor, the least preferred alternative will not have an advantage.

Step 6: Decide the importance of each advantage.

- The maximum advantage that can be ascribed to each advantage for each factor depends on the weight given to the factor, the values ranges from 20 to 100.

- The importance of advantage (IofA) for each alternative is summed up at the end of the session and the alternative with the highest IofA value is selected.

Step 7: Evaluate cost data if applicable.

- This step was ignored as there is no cost data associated with the choice of alternatives.

- If cost data exists, it is evaluated by plotting the IofA score for each alternative against the cost of selecting an alternative.

Factor & Criterion	Last Planner System		Critical Path Method		Linear Scheduling	
1. Ease of use/ implementation in linear projects **Crit.:** Easier is better **Max. Weight**: 50	**Attr.:** Easy to use and based on operational planning		**Attr.:** Convoluted in complex projects, and ineffective for linear continuous projects		**Attr.:** Used in linear projects where majority of the work is made up of highly repetitive activities	
	Adv.: understand the presence of variability in production, human focused	**IofA** 35	**Adv.:** Most commonly used scheduling method	**IofA** 0	**Adv.:** Performs optimally when applied to linear projects	**IofA** (50)
	Adv.: enhanced collaboration and communication promotes resource management	**IofA** 20	**Adv.:** Facilitates resource allocation, levelling and smoothing	**IofA** (50)	**Adv.:** Resource allocation/levelling is not possible as it lacks resource allocation and leveling capabilities	**IofA** 0
2. Promotes collaboration and communication during project execution phase **Crit.:** Higher is better **Max. Weight**: 100	**Attr.:** Planning is done mainly at project level and is therefore flexible		**Attr.:** Planning is rigid, and process focused and carried out on a strategic level		**Attr.:** Planning is carried out on a strategic level and best implemented as an effective management tool at field level	
	Adv.: More collaboration and communication during the execution stage	**IofA** (100)	**Adv.:**	**IofA** 0	**Adv:** Collaboration and communication during execution stage	**IofA** 60
7. Reduction of uncertainty and risk **Crit.:** Higher is better **Max. Weight**: 50	**Attr.:** Produces predictable and reliable workflow		**Attr.:** Complemented by EVM and PERT with statistical abilitiers.		**Attr.:**	
	Adv.: Project percent complete (PPC) and Variance Analysis (VA) can be used to reduce uncertainty and risk	**IofA** 35	**Adv.:** Statistical abilities help planners to get a better idea of time and schedule risk	**IofA** (50)	**Adv.:** There is no method to incorporate duration and production uncertainty	**IofA** 0
Total IofA		(265)		150		225

- The results of the CBA analysis show that during the construction of elevated urban highways, the LPS is preferable, subject to the selected factors and criteria.

- However, changing the factors and the criteria used in the analysis may lead to a different outcome for different types of project.

LIMITATIONS

- The sample size for the data collection limits the generalization of the results for all highway projects.
- The CBA technique requires the "Big room", and getting decision makers in the room at the same time was difficult.
- The decision makers were not familiar with the CBA method.

CONCLUSIONS

- CBA is an important decision-making method that integrates the perspective of multiple stakeholders.

- CBA fosters more collaboration and exchange of ideas during the decision-making process, enhances transparency as decisions are made based on the importance of advantage of agreed factors.

- The conclusions from the case study that may be generalized are:

(1) CBA was helpful in integrating the perspective of multiple stakeholders.

(2) CBA facilitated the identification of critical success factors necessary for selecting a suitable project scheduling method for highway projects.

thank you!

Contact:
Charles Igwe
Ph.D. Candidate
Concordia University
Montreal, Quebec
c_igwe@live.concordia.ca
514-655-8611