E-PROMETHEE DAYS 2020 MEETING

MAIN THEME : MULTICRITERIA DECISION AID FOR SUSTAINABLE DEVELOPMENT

EVALUATING INVESTMENT IN INFRASTRUCTURE BY THE MCDA THE DIGITAL SUPPORT OF CRITERIA EVALUATION

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- **MCDA overview**
  - 1. The MCDA approaches
  - 2. Aggregation and decision

2

- **Using of the BIM in the construction sector**
  - 1. Main characteristics of the construction sector
  - 2. BIM maturity in the construction sector

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- **Transport infrastructure projects**
  - 1. Infrastructure as support of the transport sector
  - 2. Cost overruns and delays in transportation infrastructure projects

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- **Ways to use of BIM to the MCDA process**
  - 1. Benefits of BIM for infrastructure projects
  - 2. Contribution of BIM dimensions to MCDA

INTRODUCTION

The success of an infrastructure project is perfectly linked to the degree of compliance with the project schedule and budget previously determined and communicated to the stakeholders

BIM
Building Information Modeling :

- Lower production costs
- Saving of time of realization due to the new collaborative modes of the teams
- Accelerating business competitiveness

MCDA
Multi-criteria decision support :

- Evaluation and prioritization of contradictory criteria
- Facility of decision-making
- Reliability of the quality of basic data

BIM brings a break from the classic definition of the tool by introducing the automation of scheduling and the concept of collaboration between actors on the same object

The interest and relevance of the use of BIM and its association with MCDA methods in infrastructure projects ?

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1. MCDA overview

	Americans and Anglo-Saxons	French-speaking	Interactive
	Total integration of all the choice criteria	Partial integration	interactive local judgment with trial and error iterations
Aggregation	Concept of multi-criteria aggregation procedure based on a single synthesis criterion	Aggregation not based on a single synthesis criterion	Iterative
Approach	Approach of the single summary criterion	Synthetic upgrade approach	*GP, STEM*, Geoffrion method, Dyer et Feinberg (1972), Zionts et Wallenius method (1983), Vincke method (1976) …
Methods	AHP, MAUT, SMART, UTA, TOPSIS	ELECTRE (I, II, III, IV, IS, TRI), PROMETHEE & GAIA	

There is no ideal method

The choice of method and the performance of the resulting decision depends on the data and the nature of the problem

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2. Using of BIM in the construction sector

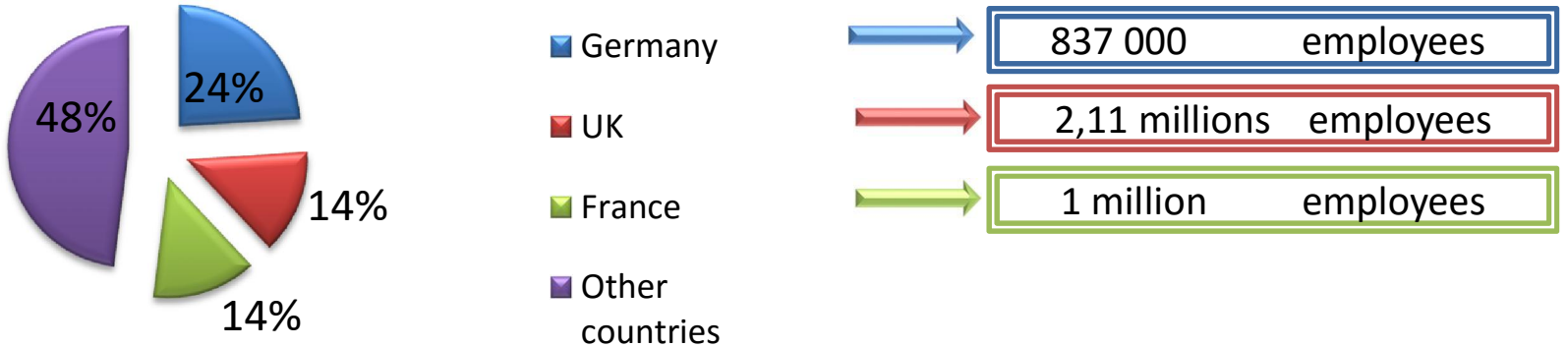
1. Impact and characteristics of the construction sector

Across Europe, BIM is now placed at the heart of the digital transition priorities for the building sector. The actors involved in the building sphere (public authorities, software publishers, companies, MOA, MOE, manufacturers, etc.) are being called upon for its massive deployment in view of the expected gains.

Results of two surveys released in 2018. (1) Batiactu group on the use of digital and digital tools by building professionals. (2) LGM Group, KYU Lab and ACTH. The development of BIM: European Benchmark.

Importance of the construction sector in the European economy

Construction sector production (2015)



The construction sector of Germany, Great Britain and France together accounted for more than half of production, ie 568.7 billion euros

	RANK	PRODUCTION IN 2015	CONTRIBUTION TO GDP IN 2015
Germany	1st	262,9 billion Euros	9,8%
UK	2nd	153 billion Euros	6,3%
France	3rd	152,8 billion Euros	8,0%

2. Using of BIM in the construction sector

2. BIM maturity in the construction sector

	Number of construction companies in top 50 Europe (2017)	Percentage of employees with computers	Launch of the first BIM initiatives
Germany	1	40%	2015
UK	12	57%	2011
France	3	43%	2014
Sweden	4	65%	2009

Launch of BIM and level of equipment in the computer construction sector

The disparity in equipment rates between the European countries studied confirms the correlation between the maturity of BIM and the level of equipment of employees

Number of employees	Number of companies
Less than 20 employees	549 969
From 20 to 49 employees	7 251
From 50 to 99 employees	1 309
From 100 to 499 employees	586
From 500 to 999 employees	21
From 1000 employees and more	3
More than 20 employees	9 170
Total	**559 139**

The number of French companies in the building sector with less than 20 employees represented 98%

Benchmark of BIM objectives, challenges and maturity in Europe

BIM objectives	BIM digital transition challenges	BIM maturity level
Germany		
By 2020: • New digital culture of construction • New standards for infrastructure	Support for the digital transition to preserve the country's leadership in the European construction sector	* German construction companies' BIM sensitivity remains moderate * Government plan to impose BIM in the public domain
United Kingdom		
Reduction of construction costs incurred by public project management	• Gradual adoption of BIM and related software • Animation of local networks of construction actors and encouragement of feedback	Advanced level of maturity NBS study (2016): 96% say they are aware of the existence of BIM (successful communication) and 48% claim to use BIM in the design and implementation of projects. * Government plan imposing BIM in the public domain
France		
Generalize the command in BIM throughout the construction * Deploy BIM in the territories by supporting the skills development of all these professionals	• Tipping into the era of collaborative work • Divide between large structures with the means to invest and train in NTICs and very numerous SMEs, which will find it more difficult to adapt	The level of maturity of the use of BIM in French companies is moderate
Sweden		
• Implement sustainable programs • Having buildings that are always more efficient, faster to build and cheaper • Having buildings with high energy performance	Large Swedish construction groups are the first to claim the benefits of using BIM. With their expertise, they push for the digital transition of the building	BIM adoption so widespread in Sweden that the best examples have developed despite the lack of clear government directives

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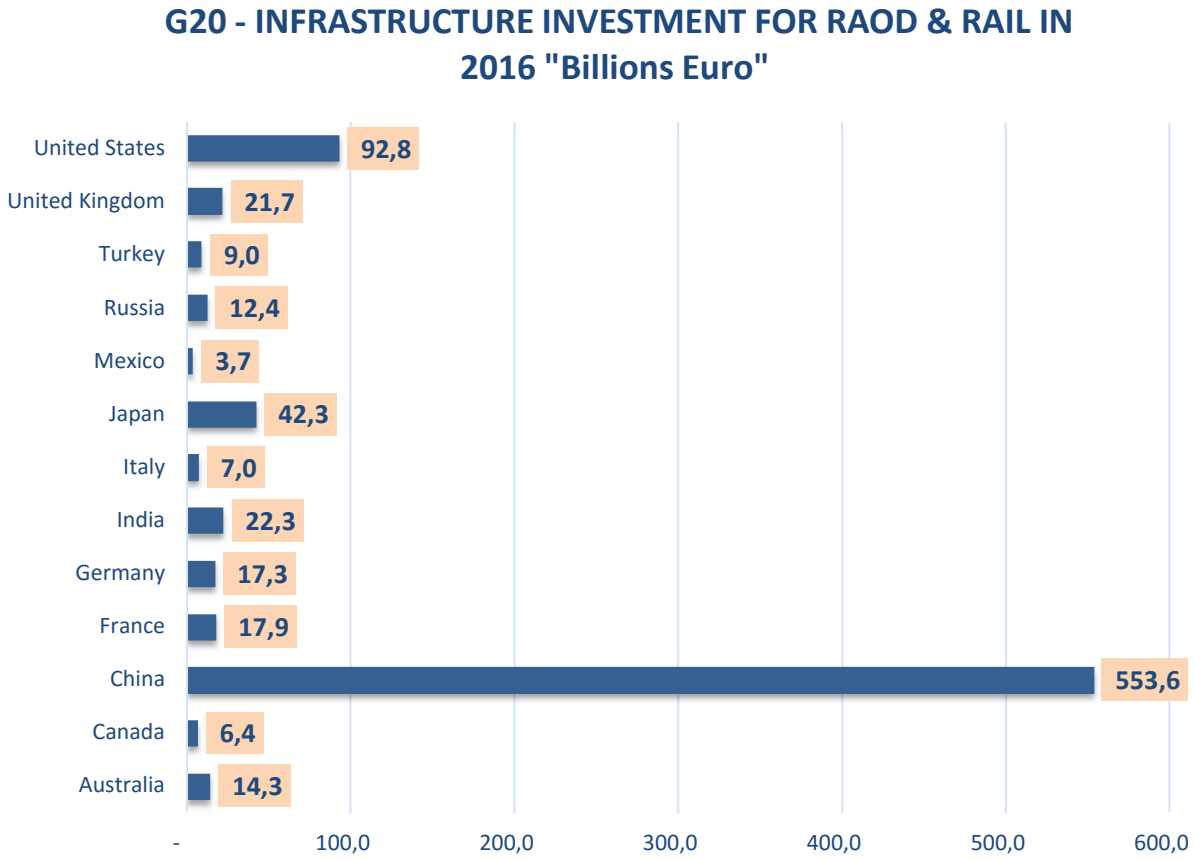
3. Transport infrastructure projects

1. Impact of infrastructure in the transport sector



In 2016, the amount of investment in infrastructure "roads and railways" of 13 G20 countries reached 821 billion euros

Source: ITF Transport Statistics: Transport infrastructure investment and maintenance

The importance allocated by each countries on this subject

The delay to be made up for densifying the transport network

3. Transport infrastructure projects

2. Cost overruns and delays in transportation infrastructure projects

	Big Dig in Boston	Rapibus in Gatineau
Title	5.5 km underground highway project called Big Dig in Boston (US)	Bidirectional lane project exclusive to Rapibus buses over a distance of more than 12 kilometers in the city of Gatineau, Quebec
Initial budget	$ 2.5 billion	$ 233.5 million
Final cost	$ 14.64 billion	$ 282 million
Over budget	5.85 times	20.8%
Start of works	1991	2010
Inauguration	2007	2013
Deadlines	not respected (9years late)	not respected (25 months late)
Explanation of overruns	The engineers and other professionals assigned to the project for this underground highway project misjudged the time required and the costs of the work. Leaks of water and gas, design flaws have greatly affected the project	The announced deadline was established when the degree of definition of the project was not sufficient to allow a fair assessment of its duration. While for the budget overrun is mainly due to additional direct costs arising from changes to the scope of the original work and indirect costs undervalued

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4. Ways to use of BIM to the MCDA process

1. Benefits of BIM for infrastructure projects

BIM has many advantages for the realization of infrastructure projects, and during all phases of a project and especially during design studies :

- detailed and fairly realistic virtual projections of the work ➔ anticipate any modification without having any financial consequences

- possibility to ensure soon enough whether or not financial criteria and project execution deadlines are met

- extract estimates of the cost of the project and to make simulations of the budgetary impact of design modifications

- reduce errors in geometry, and in interaction between different trades, especially following design changes or corrections

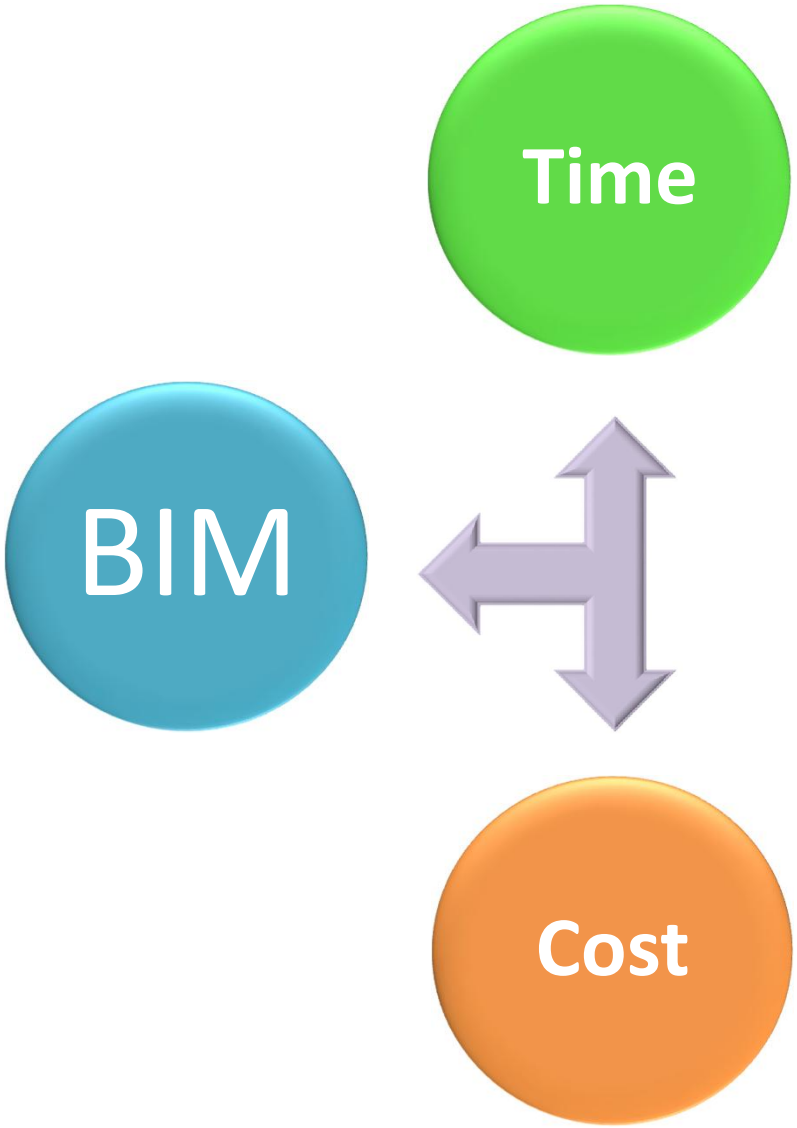
- compliance with the standards in force and the quantitative and qualitative criteria selected for the project

- simulations of the environmental performance of a project if they are required as a criterion for its evaluation

- identify and detect any interference, conflicts and other construction problems at the study phase stage before starting work

4. Ways to use of BIM to the MCDA process

2. Contribution of BIM dimensions to MCDA



The 4D dimension of the BIM process combines time management with plans and 3D objects, which allows possibilities for real-time simulation of project progress

ensures the automation of construction cycles and phasing, allowing problems of to be easily and effectively traced

the 5D dimension, provides a level of detail of project costs that is extremely useful in the design stage and allows instant generation of the budget and financial projections of project costs over time

improves the precision of the estimates and the saving of time in collecting costing data

CONCLUSION

BIM represents a crucial interest in the process of measuring the values of quantitative criteria to improve the efficiency of decision-making. Thus, BIM offers decision-makers enormous possibilities to considerably improve the quality, speed, precision, value and sophistication of their cost and time data.

Identifying the tangible benefits of BIM, in particular those related to its 4D (time) and 5D (cost) dimensions during the feasibility study phase, could be improved considerably if the barriers that are commonly noted for the appropriation of tools have been neutralized, such as :

- **the resistance to change,**
- **the lack of human resources expertise allocated to the project,**
- **and the lack of a unified approach.**

THANK YOU FOR YOUR ATTENTION