

HOW TO CHOOSE THE BEST MEDIA TO IMPLEMENT THE CHOOSING BY ADVANTAGES (CBA) TABULAR METHOD

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ABSTRACT

Choosing by Advantages (CBA) applications in the construction industry have been growing over time and teams need to decide which tools they will use to facilitate and document a CBA decision. This paper aims to determine which criteria should be considered when deciding on the tool/media to apply the CBA Tabular method? Researchers analyzed four different tools: (1) analog, (2) spreadsheet, (3) digital whiteboard, and (4) CBA decision-making software. These four tools were selected based on direct experience of the authors on four case studies. Researchers also conducted a survey to expand experiences, collect information on alternatives, and identify factors and define criteria to help users to select the tool. The conclusion is that there is no-one-size-fits-all solution, and the authors therefore encourage teams to choose the best tool that suits their context. This paper aims to help teams be aware of multiple alternatives and of the consequences that come with each tool.

KEYWORDS

Analog, choosing by advantages, collaboration, digital tools, decision-making

INTRODUCTION

When implementing CBA, users must decide which tool will be used to support the decision-making process. It is often argued that the most effective way to collaborate is face-to-face. Nevertheless, there are phases in a project where team members are not able to co-locate, e.g., a design team where the different parties are located across the world. For a virtual team to perform at a high level, it is necessary to apply digital tools that are easy to use (Hildebrandt, Jehle, Meister, & Skoruppa, 2014), and that help the team to have a productive conversation to be able to agree on a decision. Over the last couple of years, digital ways of working have become popular. Before the COVID-19 pandemic, most teams had the analog alternative available, but now most teams have found ways to work remotely. This has also allowed for more alternatives when it comes to choosing a

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medium or tool to support the decision-making process. Reviewing the IGLC publications, there are no papers comparing different media for CBA application. Thus, this paper compares the four tools: (1) analog, (2) spreadsheet, (3) digital whiteboard, and (4) CBA decision-making software based on cases and a survey to better understand the users' need to identify factors and define criteria to help the teams decide on the tool.

CBA TABULAR METHOD

CBA is a multi-criteria decision-making system developed by Suhr (1999) that differentiates between alternatives based on their advantages. The decision is structured in a logical and transparent way and uses a clearly defined vocabulary so that a group can objectively formulate and discuss the different decision criteria with minimal emotional interference (Schöttle & Arroyo, 2017; Schöttle, Christensen, & Arroyo, 2019). CBA isn't yet widely applied, but documented cases show that CBA provides a high potential to better understand the different preferences existing in a group. This is an important aspect when a project team has to make decisions collaboratively (e.g., in IPD projects). The most used and best-known method is the CBA Tabular method. Figure 1 shows the different steps of the Tabular method.

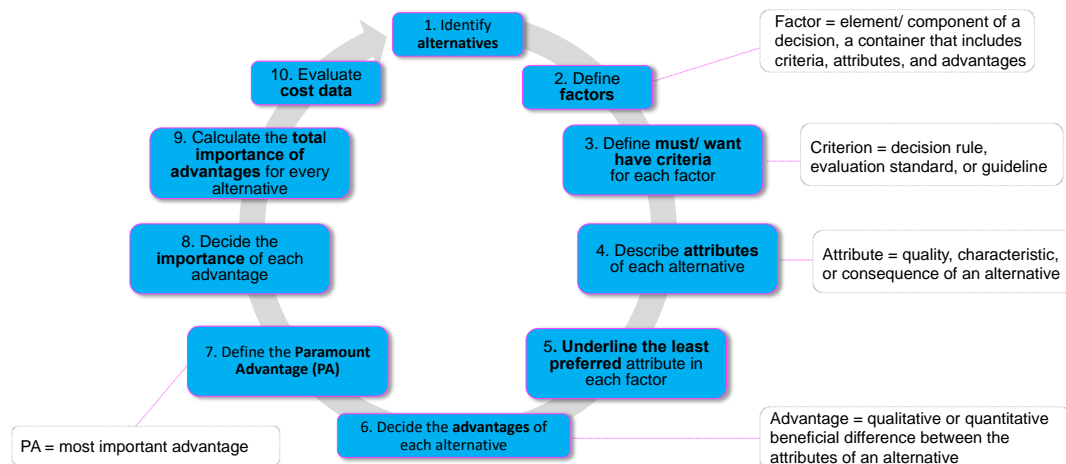


Figure 1: CBA Tabular method (Schöttle et al., 2019 based on Arroyo, 2014)

RESEARCH METHOD

This paper aims to determine which criteria should be considered when deciding on the tool/media to apply the CBA Tabular method. To differentiate between the alternatives, we identified factors and defined criteria to help users to select the tool. Therefore, a survey was carried out in February 2022 to collect data regarding the experience of CBA to a selected group. To ensure the level of experience with the correct implementation of the CBA Tabular method, the selection of participants was based on the following two factors: (1) participants were trained in the CBA Tabular method and (2) authors guided the participants in making a decision using the CBA Tabular method. After this, participants were asked to give feedback regarding their recommendation and were asked to specify which attributes a tool should have in order to make the use of the CBA Tabular method as easy as possible. The answers were reviewed based on content analysis (Mayring 2010). In total, 23 responses were submitted and analyzed. 29.2 % of the respondents were female and 70.8 % male. The number of moderators and participants was the same. The projects were located mostly in the USA, followed by Europe, South

America, and Canada (see Figure 2). The survey results are used to elaborate on the use and efficiency of the different tools.

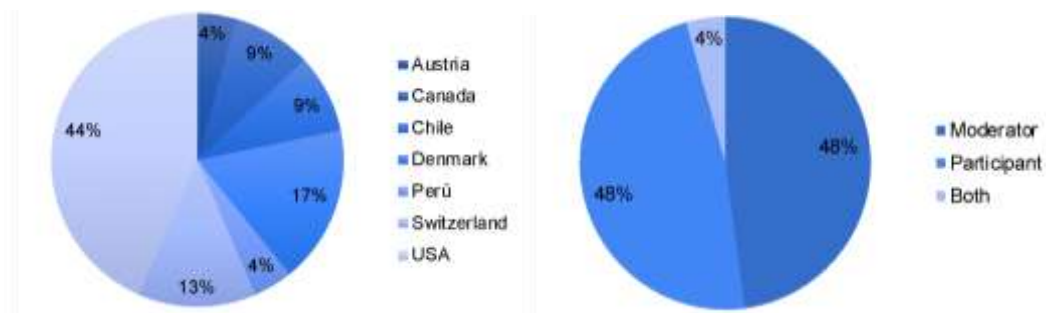


Figure 2: Background information of respondents

CASE STUDIES

The four case studies presented were cases where the author moderated different teams through a specific decision with the CBA Tabular method, and in all the first time for the teams. The cases give an overview of the four alternative tools used to support a CBA process: (1) analog (paper and sticky notes), (2) spreadsheet, (3) digital whiteboard, and (4) CBA decision-making software that the authors focused on in the questionnaire. The questionnaire was also sent to the participants of these cases.

CBA TABULAR ANALOG

The analog use of CBA with sticky notes on a white board or on paper has been documented in several case studies (e. g. Arroyo, Tommelein, & Ballard, 2013, Arroyo 2014). In this case, the team had to select acoustic ceiling tiles from a global and sustainability perspective. Figure 3 shows how the team was able to collaborate in the scoring of the importance of advantages. Here, the sticky notes are organized on a scale from 0 to 100. The team decided that the paramount advantage (PA) would be the acoustic difference of the ceiling tiles, since that impacted the acoustic isolation of the meetings rooms and would make the biggest difference in the usability of the space. Using this as the point of reference, each of the advantages were moved either up or down relative to the PA. The ability to physically move the sticky notes was appreciated by the facilitator and the team. Conversations about advantages were made openly face-to-face; assumptions of each team member were made explicit; and group conversations created a shared understanding of the importance of each advantage. Using sticky notes was an effective medium, as the team immediately understood the dynamic, and it was easy to learn how to use them.

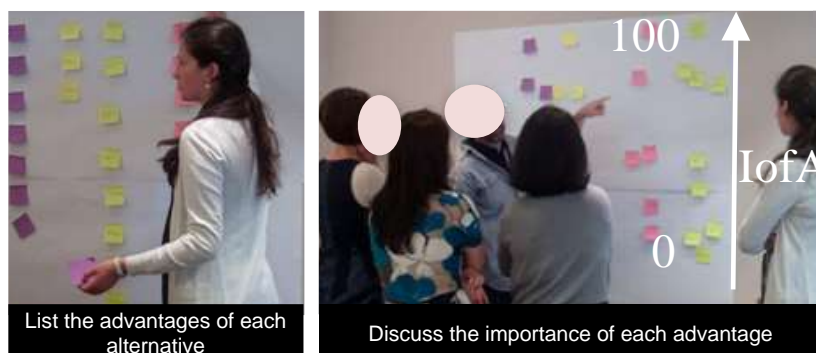


Figure 3: Image of working with the analog medium (Arroyo et al., 2013)

CBA TABULAR SPREADSHEET

In the following case, an Austrian General Contractor (GC) was selecting partners for a small Integrated Project Delivery (IPD) project in social housing in November 2020. The goal of the project was the development of a timber module that would fit the specific project and could also be used for future projects. The timber production line was the GC's own inhouse team. Regional small and medium-sized enterprises (SME) were interviewed to be partners during design development of the modules to optimize the production line and to produce the modules together not only for this project, but also for upcoming future projects. After explaining IPD to the different participants, interviews were conducted regarding the mindset of the potential team members. The information from the interviews were transmitted into the CBA Tabular format. The advantages were then determined, and the Importance of Advantages (IofA) assigned. Figure 4 shows the table and the scale of importance for the selection of the partner responsible for doors and windows. Using the Tabular method helped the GC to see the differences between trades in order to choose companies with a collaborative mindset. It also helped them to find solutions regarding capacity issues based on the size of the companies. For example, they brought two companies for the building equipment on board, which together developed the technical services.

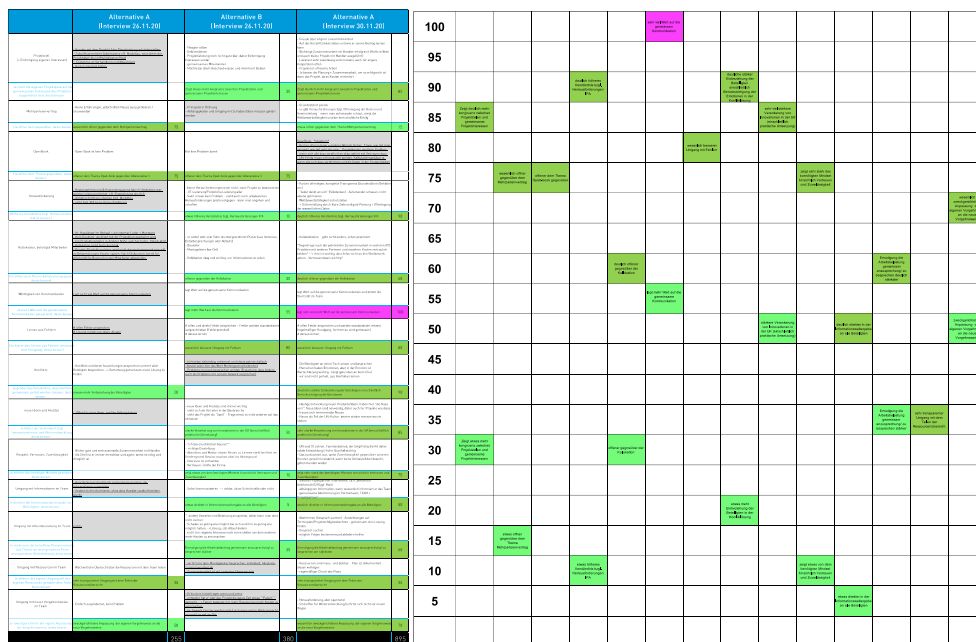


Figure 4: Image of the spreadsheet used to select the partner for doors and windows

CBA TABULAR DIGITAL WHITEBOARD

In this case study, a digital whiteboard was used to select the physicochemical process for a wastewater treatment plant. In separate sessions over a period of three months (January-April 2022), the Tabular was prepared with a small group of four people, including the Swiss public owner, and then discussed with a wider group. The decision initially consisted of eight alternatives, with 22 factors and 22 criteria. After defining the advantages and before assigning the importance through discussions and by seeing the differences, the team was able to reduce the number of factors and criteria to 13 (see Figure 5). The team was able to add and share information directly on the board, which helped them achieve a common understanding regarding attributes and advantages.

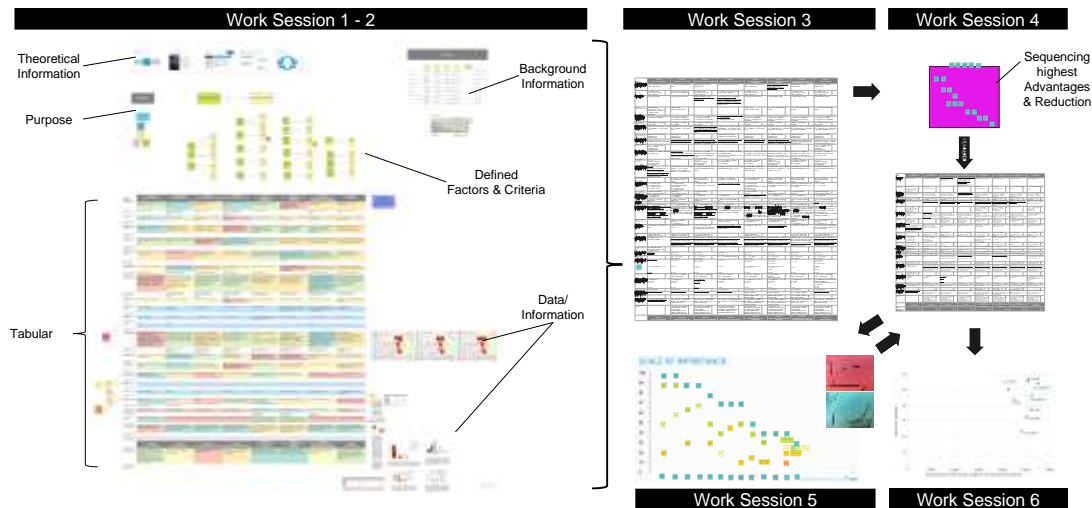


Figure 5: Image of the Digital Whiteboard for CBA Tabular use

CBA TABULAR SOFTWARE

Another way to document CBA decisions is through specialized software, such as Paramount Decisions. In this example the project team used software that helped them input CBA information step by step (see Figure 6). The inputs then are used to create graphics that summarize the decision. The decision was to choose a Demountable Glazing System for a partition wall in collaboration between the construction, design, and owner team. In this case, the GC team was introduced to CBA by an internal coach. One of the project engineers and the project estimator where particularly engaged, first understanding the CBA Tabular method and then learning how to use the software. The project engineer summarized the attributes of the alternatives, collecting four suppliers' information from a Request for Proposal (RFP). The GC team then asked the design team for additional factors to consider for aesthetics and functionality. Finally, the team met with the owner, presented an overview of CBA, and used the software scoring system to obtain the IofA from the owner's perspective. The last step was to make a decision by comparing the IofA with cost. The owner appreciated the team's preparation and transparency of the process, and the ability to separate cost vs. value. The software's reporting function was used to share this decision with the team.

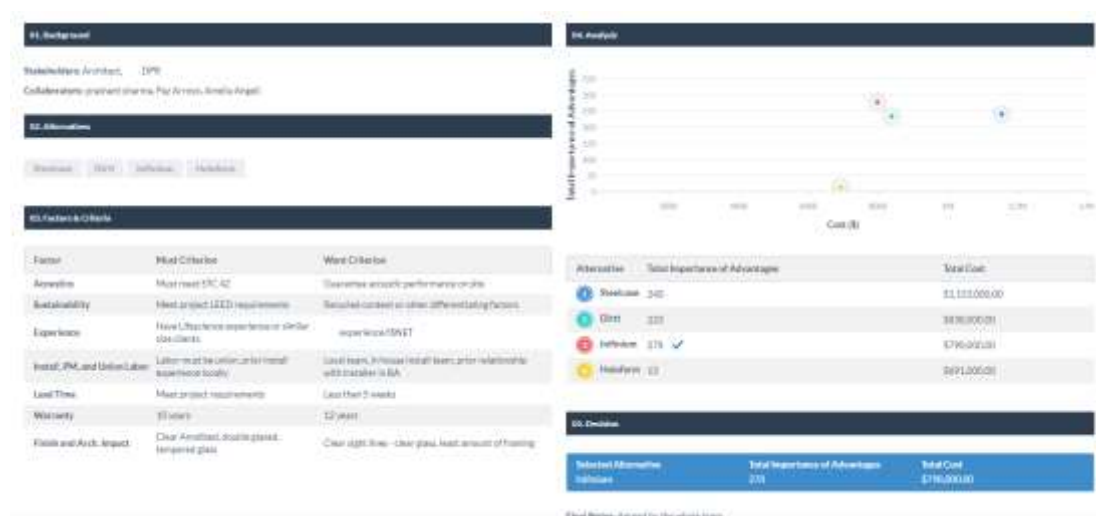


Figure 6: Image of choosing a demountable glazing system using CBA software

COMPARISON DATA ANALYSIS AND FINDINGS

USES AND RECOMMENDATIONS

Most of the respondents (61 %) used just one tool (see Table 1); a smaller number (26 %) used two, and even fewer used multiple tools. Overall, the spreadsheet was most frequently used (38 %) for the CBA Tabular method, followed by analog and the digital whiteboard. CBA-specific software was rarely used, so a clear conclusion cannot be drawn. Therefore, it is not surprising that the spreadsheet was recommended most frequently (52 %) (see Figure 7). Furthermore, it seems like fewer are likely to recommend the digital whiteboard as 27 % have tried it but only 19 % would recommend it. However, when an analog process is not possible due to remote working, a digital solution such as the digital whiteboard should be considered since it comes closest to the analog process. The preference regarding the spreadsheet can also be explained by the fact that it is a tool that people are familiar with, while the digital whiteboard is still a novel technology for many in the construction industry. PowerPoint was added as an experience by one respondent, but it wasn't recommended or named by other respondents. Thus, PowerPoint does not seem to be a preferred option and will not be further considered.

Table 1: Decision categories in which CBA Tabular was used (Abbreviation used in the table: P = Participant, M = Moderator, A = Analog, S = Spreadsheet, DW = Digital Whiteboard, SW = Software, PP = PowerPoint)

#	Role	Stakeholder/ Team member	Decision categories in which CBA Tabular was used					Experienced tools					
			Building Design	Building System	Materials	Formwork & scaffolding	Software	A	S	DW	SW	PP	Recommendation
1	P	x							x				S
2	P			x						x			DW
3	M		x						x	x			S
4	M	x	x	x				x	x				S
5	P		x		x			x					A
6	Both	x	x	x	x			x	x	x	x		S
7	M	x	x						x				S
8	M	x	x	x				x	x				A
9	P		x						x				S
10	M				x			x	x				S
11	P		x							x			S
12	M	x		x	x			x	x				A
13	M						x		x				S
14	M			x				x					A
15	M	x		x				x	x	x			DW
16	M	x				x		x		x			A
17	P		x		x					x			DW
18	P		x						x			x	S, can see DW
19	P			x						x			DW
20	P		x	x	x				x	x	x		DW
21	P			x					x				S
22	P			x						x			S
23	M				x						x		SW
8			11	11	7	1	1	9	14	10	3	1	

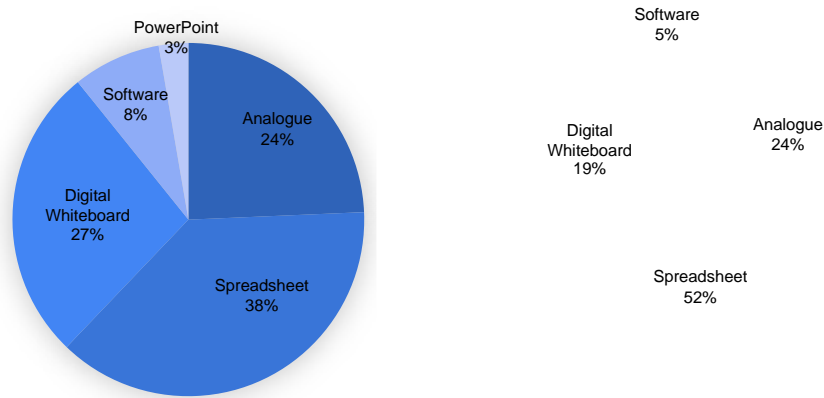


Figure 7: Tools used (left) and tools recommended (right)

INDICATION BASED ON FOCUS

Table 2 shows respondent feedback regarding their recommendations. Reducing the answers to the core of their statements gives an interesting overview of the focus of the respondents. It indicates that people prefer the spreadsheet focusing on this relatively easy and familiar process, whereas people recommending the digital whiteboard focused on the dynamics of the process with the flexibility and visualization of information to easily achieve a common understanding. People preferring the analog tool concentrated more on the social process within the group. For them, driving collaboration through interaction was key. It should be noted that most of the respondents experiencing the digital whiteboard did not experience the analog implementation. One respondent recommended the software, because of its automation. Based on the engineering and technical mindset of the construction industry, it is understandable that the spreadsheet is preferred, and that there is interest in using software. Nevertheless, it shows us that we need to educate people to focus on the social process that every group decision contains to overcome phenomena such as groupthink (Schöttle et al., 2019). Some of the respondents gave clear feedback and expressed the importance of interaction during the decision-making process. This could be an indicator that each group might make a different decision with the same data simply based on the medium. Thus, the analog way should be considered when the team members are new to each other, and the Tabular method is being used for the first time. This will also facilitate team building.

IDENTIFIED FACTORS

Based on the responses to the following three questions:

- Which attributes should a tool have to make the use of the CBA Tabular method as easy as possible for the team?
- Why do you recommend this tool?
- How did the tool/tools help with team collaboration?

17 factors were identified that can be considered when selecting a medium for the decision-making process. Figure 8 gives an overview of these factors based on how many respondents the factor named. This gives insights regarding their priorities in general. The most frequently identified factors were flexibility (43 %), visualization (39 %), and ease of use (39 %), followed by documentation (35 %).

Table 2: Focus behind the recommendation

Tool	Reason given for recommendation	Wording	Focus
Spread-sheet	<ul style="list-style-type: none"> • <i>It's familiar and it works for sharing</i> • <i>Automatic calculation, but flexible enough to jump around.</i> • <i>Simple, easy to adjust and customize.</i> • <i>Worked well for us.</i> • <i>A spreadsheet is easy to use, and it can be formatted as needed for visual sharing (on a screen, a PDF, or on paper).</i> • <i>Thorough and effective.</i> 	Familiar, Sharing, Simple, Easy, Adjustable, Effective	Systematic framework of the process
Analog	<ul style="list-style-type: none"> • <i>All participants are seeing the big picture and have the opportunity to make a change. A digital whiteboard is a good idea for non-allocated decision makers.</i> • <i>Easy to use, facilitates team participation and collaboration</i> • <i>Because it allows a more direct interaction (face-to-face) between the people who participate in the decision, it also strengthens the feeling of commitment to the decision made.</i> 	Big picture, Collaboration, Direct Interaction, Commitment, Easy	Social process
Digital Whiteboard	<ul style="list-style-type: none"> • <i>Easy to use. Editable. Great possibilities for visualization.</i> • <i>It is visual and collaborative and works within the constraints of hybrid or full virtual [workplaces].</i> • <i>High flexibility, interactive, easy to work with, team has full access anytime.</i> • <i>It gives the most freedom while still providing a framework to work within</i> 	Flexibility, Visualization, Interactive, Discussion, Easy	Dynamic of process
Software	<ul style="list-style-type: none"> • <i>Automates the process</i> 	Automation	Automation of process

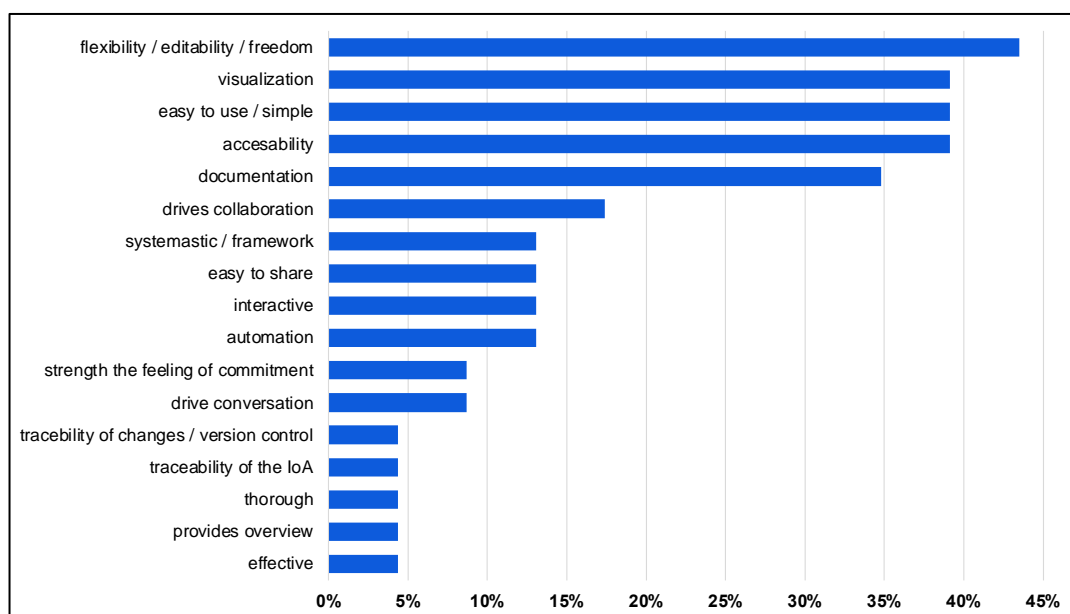


Figure 8: Identified factors (Based on % of respondents' input)

DISCUSSION

The medium used to implement the CBA Tabular method can have an impact on the team dynamic and understanding. It is therefore important to understand the specific context and the needs of the project team to better align on a decision. As most respondents had only experienced one tool to support the CBA this paper could serve as inspiration for future decision processes. To better select between the four alternatives, the following criteria (Table 3), can be defined using the identified factors. If a project team needs to decide which medium is best to use on a given project, the criteria pool can be used to quickly decide.

Table 3: Factors and criteria to choose the tool/media

Factors	Criteria
accessibility	Easier accessibility is better.
automation	Greater automation is better.
documentation	Clearer documentation is better.
drives collaboration	The more it drives collaboration, the better.
drives conversation	The more it drives an open conversation, the better.
easy to share	The easier it is to share, the better.
easy to use / simple	The easier it is in use, the better.
effective	The more effective it is, the better.
flexibility / editability / freedom	Higher flexibility/editability is better.
interactive	The more it is interactive, the better.
provides overview	The better it provides an overview, the better.
strengthen the feeling of commitment	The more it helps strengthen the feeling of commitment, the better.
systematic / framework	Higher systematic framework is better.
thorough	The more thorough, the better
traceability of the lofA	Easier traceability of the lofA is better.
traceability of changes / version control	Easier traceability of changes (version control) is better.
visualization	Greater visualization is better.

CONCLUSIONS

In this paper we have assessed the use of media or tools to support the CBA Tabular method. Four different tools were assessed: (1) analog, (2) spreadsheet, (3) digital whiteboard, and (4) CBA-specific software. This is not an extensive list, but it includes the most used. Four case studies are presented to exemplify the use of each tool and its advantages. Then, based on 23 international survey respondents, the use of the tools was analyzed in terms of what mattered for the participants. It became clear that most had experience with only one tool. It was also clear that no one solution was considered perfect in all cases. From the survey, 17 factors and criteria can be considered when making the decision of selecting a CBA tool. However, not all factors will be relevant for all contexts. Therefore, this paper offers a list of factors, criteria, and attributes to consider

when selecting a tool for a decision process in its specific context. One important element in evaluating tools is whether the team can meet face-to-face or if the team must meet in a hybrid or remote environment. Thus, this paper presents a summary of tools that were used to facilitate and document CBA internationally and is a good starting point to decide which tool would be best for a team by using the identified factors and criteria. The authors caution readers to focus on preparation in advance to teach CBA concepts and allow time for practice, as well as choosing a facilitation and documentation tool.

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