

MATHEMATICAL APPLICATIONS QUALITY: A WAY TO PROMOTE BUSINESS DECISION MAKING

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Abstract: Business decision making (BDM) increasingly depends on mathematical applications that support analytical processes, information evaluation, and problem-solving activities. This study examines the influence of computational quality, access to mathematical content quality, and graphic calculators' quality on BDM, while also investigating the direct and moderating role of self-confidence. A quantitative research design was adopted, and data were collected from 319 respondents using a structured questionnaire. The data were analyzed using Structural Equation Modeling. The findings reveal that computational quality, access to mathematical content quality, graphic calculators' quality, and self-confidence significantly enhance BDM. Among these factors, graphic calculators' quality emerged as the strongest predictor of BDM. The results further indicate that self-confidence positively influences BDM and significantly moderates the relationship between graphic calculators' quality and BDM. However, self-confidence does not significantly moderate the relationship between computational quality and BDM or between access to mathematical content quality and BDM. The study contributes to literature by integrating technological and psychological factors within a unified framework and provides practical insights for organizations seeking to improve decision quality through mathematical applications and user development initiatives.

Introduction

In the current business environment, business decision making (BDM) is one of the most important functions as the quality of decisions can affect the effectiveness of running the business, the competitiveness of the business and the profitability of the business [61]. A more data-driven demands for business help the people to analyze complex data, predict future consequences, and make decisions about their best course of action [27]. But there are still many organizations that have not overcome the problems of making timely and accurate decisions because they lack analytical skills, computing power and access to valid data. Under such conditions, mathematical applications have proved to be useful tools that help decision makers to process data [36], to carry out analysis and to draw conclusions that can help make a well-informed business decision. Technology and mathematical tools have become an integral part of business functions [54], changing the way businesses solve problems and make decisions.

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There are several Mathematical applications which offer functionalities that make it easier to make decisions in business [42, 54]. The applications will help users to carry out complex calculations, retrieve specific mathematical content, visualize information using graph representations and analyze various business situations more effectively. The quality of computational methods used in calculating mathematical components [11], often called computational quality, is crucial to obtaining meaningful results from business analyses. Similarly, users can use good mathematical content to get relevant information, exercises and analytical resources to enhance understanding and decision quality. In addition, the use of graphic calculators and other technological tools can support the visualization of mathematical concepts and data patterns and facilitate interpretation of information and identification of appropriate solutions for the decision maker [67]. With the increasing reliance on analytical technologies, understanding the role that these dimensions play in BDM is an important area of study.

The role of mathematical knowledge, technological tools and decision support systems [18, 41] on improving the performance of organizations and the effectiveness of managers has been emphasized in previous studies. It has been found that mathematical skills are correlated with analytical thinking, problem solving skills and strategic evaluation process [35, 53]. Likewise, various types of decision support technology have been shown to support information processing and evidence-based decisions. Although these developments have been made, the literature is still diverse about the role of mathematical applications in BDM. Previous research has focused on mathematics education, technology acceptance, the use of decision support systems or computational tools individually [26, 45], and few studies have attempted to study the overall impacts of various facets of mathematical application quality on BDM [3, 54]. As a result, there is no systematic empirical evidence to explain how these three quality factors of computational, access to mathematical content, and graphic calculators' quality relate to the effectiveness in decision-making.

Another crucial constraint on literature is the lack of consideration for individual psychological properties in enhancing the effectiveness of mathematical applications. While technology offers many analytical supports, the effective use of technology can also depend on users' confidence in applying the mathematical concept and understanding the results of the analysis. People with greater self-confidence tend to be more amenable to use of technological tools [4], consideration of other options, and use of analytical evidence in decision making. On the contrary, low confidence can affect even the best mathematical resources. Although the role of self-confidence in education and technology is well recognized [5], few studies have investigated the direct and moderating effect of self-confidence on the relationship between the quality of mathematical application and BDM. This difference limits the understanding of the interactions among personal characteristics and technological features, and how this combination affects decision outcomes. To consider these literature gaps, the present study proposes and tests a model for studying the impact of computational quality, mathematical content quality and graphic calculators' quality on BDM. Moreover, the study examines the direct effect of self-confidence on BDM and analyzes whether there are moderating effects of self-confidence between the three aspects of mathematical application quality and BDM. This study combines the technological and psychological approaches to the problem which is more comprehensive than others in explaining the factors that contribute to effective decision-making processes.

This research is significant not just from a theoretical point of view, but also one of

practice. In the perspective of theory, the study advances research on mathematical applications and business decisions by creating a multidimensional model that integrates technological quality factors and confidence among individuals. It extends current understandings by illustrating how various components of mathematical applications can affect decisions and discusses boundary conditions of self-confidence, and mathematical applications. In practice, the results provide useful insights for organizations, teachers, software developers and businesspeople who want to enhance the quality of decisions using mathematical technologies. BDM can be improved by understanding the factors that support such decision making, which can help organizations choose the right analytical tools, create effective training programs and generate users' trust. Finally, the study helps to meet the goal of making informed, accurate, and effective business decisions in increasingly complex business environments that are becoming technologically rich.

Framework of the Study

The present study is based on the Technology Acceptance Model (TAM) which explains the attitude of users, acceptance and use of technological systems to carry out certain actions [14]. Findings of TAM indicated that technologies perceived as useful and easy to use will be used and utilized effectively by individuals [15, 68]. Mathematical applications in BDM are tools that the user can use to analyze information, to make calculations, to evaluate alternatives and to make well-informed decisions [54]. Important system attributes that increase the usefulness and effectiveness of mathematical applications are computational quality, access to mathematical content quality and graphic calculators' quality. Quality applications facilitate the user to get precise calculations, relevant content, and meaningful graphic representation, which help in enhancing the quality of decisions. In addition, self-confidence is a person's attitude towards the effective use of mathematical applications.

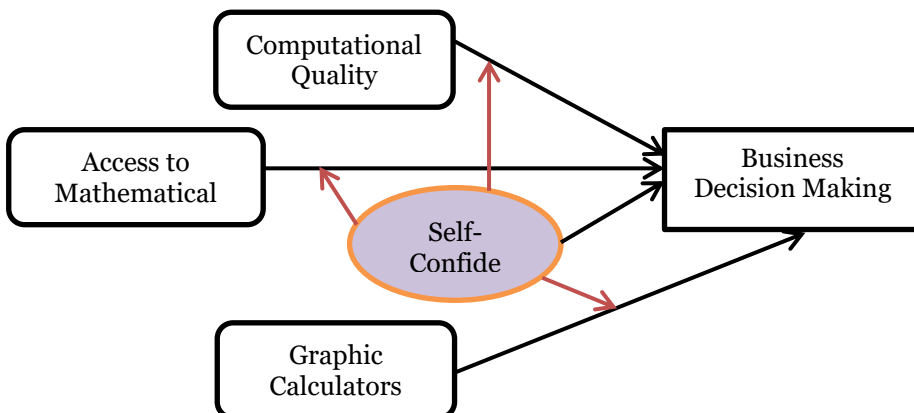


Figure 1: Framework showing the relationship between computational quality, access to mathematical content quality, graphic calculators' quality, self-confidence and business decision making

These technologies are more likely to be used and to harness their potential for decision making by users who are more self-confident. Given this, TAM is a suitable

theoretical lens to explain how the quality of mathematical application and users' confidence because of the application can jointly affect BDM. Figure 1 is the framework of this study built on TAM showing the relationship between computational quality, access to mathematical content quality, graphic calculators' quality, self-confidence and BDM.

Hypotheses Development

Computational Quality and Business Decision Making

Computational quality is the accuracy, efficiency and consistency of mathematical applications in calculating [55]. Analytical tools are essential to decision makers in today's business world to assess options, predict results, plan resources, and troubleshoot complex situations. With high computational quality, the calculations are accurate, which decreases the error rate and enhances the reliability of the results of business analysis [25]. Mathematical applications, particularly those with high computational skills, can help users analyze vast quantities of data in a timely manner to produce useful information to aid in the decision making of both strategic and operational actions [59]. Furthermore, precise calculations boost confidence in the analytical outcomes [13] and facilitate evidence-based decision making. It is known from previous studies that mathematical skills and mathematical tools are essential to problem-solving and business efficiency [55]. Thus, those who use the best computational applications are better at making informed and accurate business decisions.

Hypothesis 1: *Computational quality enhances BDM.*

Access to Mathematical Content Quality and Business Decision Making

Access to mathematical content quality is the availability, accuracy, relevance and comprehensiveness of mathematical information provided through applications [24]. Valuable content allows users to gain a better understanding of mathematical content, mathematical analysis, and problem-solving techniques that can be used within business settings [24]. Reliable information and structured analytical resources are frequently needed to assess business situations effectively as this is a requirement of decision makers. If mathematical applications present accurate content, progressive learning material, and relevant exercises then users will possess a higher ability to analyze and decide. In addition, quality content aids the learning of knowledge [6, 72] and enables the use of mathematical reasoning to solve business problems. Previous studies have indicated that mathematical learning materials with good design will increase users' understanding and involvement in the analysis process [24]. Therefore, it is expected that access to high quality mathematical content will have a positive effect on the effectiveness of BDM.

Hypothesis 2: *Access to mathematical content quality enhances BDM.*

Graphic Calculators Quality and Business Decision Making

The graphic calculator is an accurate, valid, and reliable tool for BDM [22]. The graphic calculator is a valid, reliable and accurate instrument for BDM. Graphic calculators' quality is the efficiency, usability, and utility of graphical and computing tools in the analysis of mathematical information [38, 58]. These tools help the user to make sense of the data, to see how the data relates to mathematics, and to make

complex calculations more efficiently. Graphic calculators offer visualization features that enable analytical information to be understood [20, 58], and help decision makers find trends, compare alternatives, and assess the potential effects. In business, graphical representations sometimes help to better understand financial, operational and strategic issues, resulting in more accurate decisions. Good graphic calculators also save time, make the analysis more efficient and help users think of alternative methods to solve a problem [23]. The results of several previous studies suggest that the use of technological tools can increase the user's engagement with the mathematical domain and the analytical abilities, increasing the understanding of mathematics, while improving the ability to perform calculations [22]. Hence, it is expected that the quality of the graphic calculator would positively affect BDM.

Hypothesis 3: *Graphic calculators' quality enhances BDM.*

Moderating role of Self-Confidence

Self-confidence is a person's belief that he or she can do things successfully and meet challenges [7, 64]. In terms of mathematical applications, self-confidence affects the use of analytical tools [60], the analysis of information, and the ability to apply mathematical knowledge in decision making situations. High self-confidence people tend to do more complex analysis, consider more than one option in their decision making, and trust their judgment [44, 46]. Self-confidence also decreases the anxiety of mathematical tasks and increases persistence in conducting business problems. Therefore, confident individuals are more likely to effectively use available information and technological resources to reach desired outcomes. A previous study has shown that mathematical confidence is a positive predictor of performance, learning outcomes and problem-solving skills [56]. Thus, it is expected that self-confidence is linked to improved quality and effectiveness of BDM.

Hypothesis 4: *Self-confidence enhances BDM.*

Self-confidence is one of the psychological factors affecting the use of technological and analytical resources in making decisions [43]. The quality of mathematical application is important because it establish technical capability for analyzing effectively [71], but that does not always translate into better business decisions, depending on users' confidence in using mathematical knowledge and in understanding of analysis results. People with higher self-confidence have higher levels of confidence in their abilities, use the analytical tools more and utilize available technological resources [2]. On the other hand, those who lack self-confidence might not feel inclined to use mathematical applications even if they are of good quality and functional. Thus, the quality of the application of mathematics may reinforce positive effects on BDM with an increase in self-confidence.

Furthermore, high-quality computational functions will generate accurate and reliable calculations [55]; these calculations will assist in decision making processes. However, the user needs to be confident to understand and use the outputs of computation to good effect. The more confident that they are, the more often they will use the results of the computation to assess their alternatives and make strategic decisions, thereby helping to reinforce the influence of computational quality on business decisions. Likewise, the quality of the mathematical content in access can enhance the efficiency of decision-making by presenting accurate information and

analysis. However, more self-confident people were more likely to access available information [30], comprehend more complex ideas and use the new information to solve business problems. Thus, the benefits of quality mathematical content are expected to be higher with high mathematical users' confidence [56].

Similarly, graphic calculators improve decision making by helping to visualize, explore, and solve problems. The value of graphical tools is not just about their technical features, but also on the willingness of users in using them effectively [12]. People who are self-confident will be more likely to try graphing, doing experiments on their thinking methods [63], and using their visual understanding to help them make decisions. Thus, the positive relationship between the quality of graphic calculators and BDM is expected to be enhanced by self-confidence. Based on these arguments, the following hypotheses are proposed:

Hypothesis 5: *Self-confidence moderates the relationship between computational quality and BDM.*

Hypothesis 6: *Self-confidence moderates the relationship between access to mathematical content quality and BDM.*

Hypothesis 7: *Self-confidence moderates the relationship between graphic calculators' quality and BDM.*

Methodology

This study examines the influence of computational quality, access to mathematical content quality, and graphic calculators' quality on BDM, while also investigating the direct and moderating role of self-confidence. By considering the nature of the objective of the study, this study adopted qualitative approach with cross-sectional research design. The survey method is used because it allows many respondents to be surveyed systematically and the proposed hypotheses can be tested with the data obtained from the respondents. The quantitative method is suitable for exploring the relationship between variables and testing the conceptual framework by statistics.

The target population of study are those who frequently employ mathematical applications, computational tools and analytical technologies for business-related activities. A comprehensive sampling frame was not available; hence convenience sampling was used. Convenience sampling is commonly adopted in behavioral and management research because the researcher can gain access to respondents that have the relevant knowledge and experience in terms of the phenomenon under study [21, 65]. It is especially well-adapted when respondents are chosen because they are easily accessible and willing to be surveyed.

A structured questionnaire was used to gather data, which were distributed online and offline. Respondents were briefed on the purpose of the study, and their responses were assured of confidentiality and anonymity. There was no mandatory participation in this survey, therefore, respondents can withdraw at any point of time without intimation. To evaluate the clarity, readability and reliability of the measurement instrument, a pilot study was carried out before the main survey. The questionnaire was sent to 55 respondents who had characteristics like target population. Several questionnaire items were revised based on feedback from the pilot participants to clarify, restructure and reward the items. The results of the pilot study showed good reliability with all constructs having Cronbach's alpha values above the recommended minimum of 0.70. The results of these findings catered

with the main data collection process. There were 600 questionnaires distributed to possible respondents. In the process of screening for incomplete responses, missing answers, and inconsistencies in responses, 319 valid questionnaires were obtained, yielding a response rate of 53.17%.

This sample size is adequate for PLS-SEM. Based on the ten-times rule; the minimum sample size is at least 10 times the maximum number of structural paths leading to a latent construct. In the proposed model, seven paths are passed through BDM, hence the minimum sample size is much lower than the sample size obtained. Moreover, methodological studies reported previously indicated that when sample sizes are larger than 300, these are adequate for the estimation of complex structural models and for obtaining reliable results. Therefore, the sample size of 319 is suitable for testing hypothesis and validation of models.

The current study adapted the scale items from previous studies. All items are rated on a 5-point Lickert Scale, from 1 (strongly disagree) to 5 (strongly agree). The measurement items and sources are listed in Table 1. Eight items adapted from Olukemi [55] are used to measure the computational quality. The constructs measure the accuracy of mathematical applications in computing, analytical thinking, forecasting and solving business-related problems. Access to mathematical content quality is measured using four items adapted from García-Hernández and González-Ramírez [24]. This construct evaluates the quality, relevance, accessibility, and extent of mathematical information and learning resources through apps. Eleven items adapted from the items used in Fogarty, et al. [22] are used to measure the quality of the graphic calculators. The scale measures respondents' perceptions of the effectiveness, efficiency, visualization, and usefulness of graphical and computational tools for mathematical and business-related analyses. The six items adapted from Opstad and Årethun [56] are used as measures of self-confidence. The construct shows the confidence of the respondents in understanding, learning, and applying mathematical applications to solve business-related problems and make informed decisions. Four of the items from [1] are used to measure BDM. The scale measures how well decisions made with mathematical applications are perceived as accurate, reliable, dependable and precise.

Table 1: Variable Measures

Construct	Items	Source
Computational Quality	1. "A good computational quality of applications is essential to ingredient in achieving success in business activities.	[55]
	2. Ability of applications to calculate effectively enhances business activities.	
	3. Efficiency in calculations has positive impact in quality of business activities.	
	4. Knowledge of simple arithmetic operations on wholenumbers, fractions, decimals and approximations will not enhance business activities.	
	5. Mathematical applications help in developing analytical mind.	
	6. Mathematical applications are needed in arrangement of ideas and accurate expression of thought in business activities.	
	7. Current and future trends of business can be computedwith the mathematical applications.	
	8. Investment opportunities could be taken with relevant analytical skills.	
Access to Mathematical Content Quality	1. Applications provide a good level of information.	[24]
	2. Applications have a variety of exercises for my business.	
	3. It presents accurate progression of the exercises in terms of complexity.	
	4. Proper extension of readings information is available through applications.	

Table 1: Variable Measures (cont...)

Construct	Items	Source
Graphic Calculators Quality	1. Computing power makes it easier to explore mathematical ideas in business.	[22]
	2. I know calculators are important, which I need to use in business.	
	3. Computers and graphics calculators are good tools for calculation in business.	
	4. I think using technology is good to make it worthwhile for business.	
	5. I think using such applications saves too much time.	
	6. I prefer to do all the calculations and graph myself, by using calculators.	
	7. Using technology for calculations makes it easier for me to do more realistic applications.	
	8. I like the idea of exploring mathematical methods and ideas using technology.	
	9. I want to get better at using computers to help me with business activities.	
	10. The symbols and language of mathematical applications are good enough.	
	11. Having application technology to do routine business work makes me more likely to try different methods and approaches.	
Self-Confidence	1. I have a lot of self-confidence when it comes to mathematical applications.	[56]
	2. I learn mathematics applications easily.	
	3. I believe I am good at solving mathematics problems through applications in business.	
	4. I can solve mathematics business problems without too much difficulty through applications.	
	5. Mathematical applications do not scare me at all.	
	6. I expect to do well in any mathematics applications which is use.	
Business Decision Making	1. Based on the information from mathematical applications, the outcome of the business decision that I make is usually precise.	[1]
	2. Based on the information from mathematical applications, the outcome of the business decision that I make is usually dependable.	
	3. Based on the information from mathematical applications, the outcome of the business decision that I make is usually correct.	
	4. Based on the information from mathematical applications, the outcome of the business decision that I make is usually accurate.”	

Data collected were analyzed using PLS-SEM with the software of SmartPLS 4. PLS-SEM was chosen because it is suitable for prediction-oriented studies, can be used to analyze complex research models, and can be used to analyze moderating effects. The analysis was carried out in two steps. The measurement model was assessed using factor loadings, Cronbach's alpha, CR and AVE. Second, the structural model was evaluated by path coefficients, t values, p values, and moderation analysis by the bootstrapping procedure to test the proposed hypotheses.

Findings

Demographic Profile of Respondents

Demographic characteristics of the 319 respondents for the study are shown in Table 2. The responses showed that the females of the respondents constituted 25.0% while the males made up 75.0% of the respondents. In terms of age, the 25-34 age group was the largest group (36.4%) followed by the age group 35-44 years (28.5%). This indicates that most of the participants were in the prime working age group and probably active in decision making and analytical activities. In terms of marital status, 64.9% of the respondents were married, 30.1% were single, and 5.0% were classified in other categories. Regarding educational status, most respondents

had a master's degree (48.0%), and then a bachelor's degree (40.1%).

Table 2: Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	239	75.0
	Female	80	25.0
Age	Below 25 years	52	16.3
	25–34 years	116	36.4
	35–44 years	91	28.5
	45–54 years	42	13.2
	Above 54 years	18	5.6
Marital Status	Married	207	64.9
	Single	96	30.1
	Other	16	5.0
Education Level	Bachelor's Degree	128	40.1
	Master's Degree	153	48.0
	PhD Degree	10	3.1
	Diploma/Professional Certification	28	8.8
Experience Using Mathematical Applications	Less than 2 years	48	15.0
	2–5 years	106	33.2
	6–10 years	98	30.7
	More than 10 years	67	21.1

Diploma or professional qualification was 8.8%, and PhD degree holders were 3.1%. Respondents have experience with mathematical applications, 33.2% have 2 to 5 years' experience and 30.7% have 6 to 10 years' experience. In addition, 21.1% were experienced over 10 years, indicating that most respondents were adequately exposed to math applications and analytics technology to give meaningful answers related to objectives of the study.

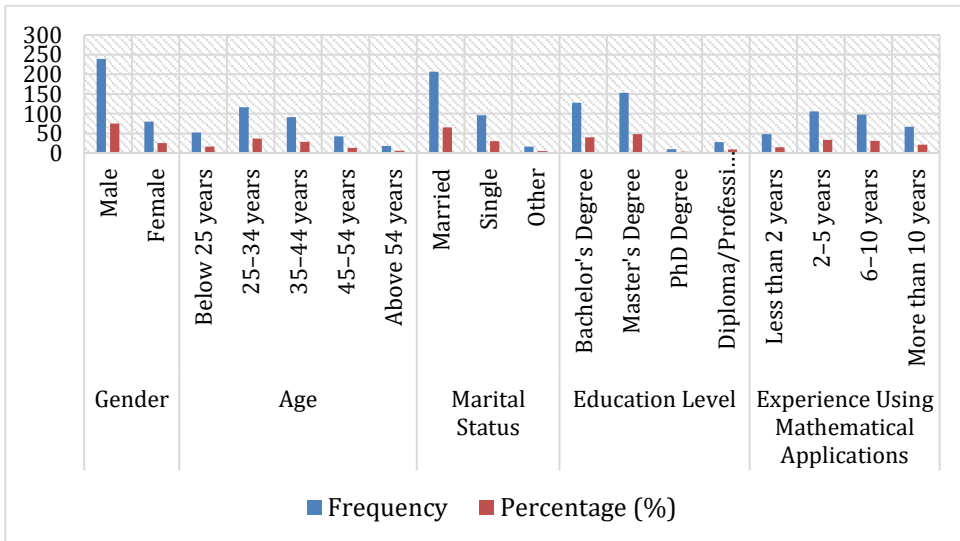


Figure 2: Demographic Profile of Respondents

Results (PLS-SEM)

Results of the measurement model analysis by calculating factor loading, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE)

are shown in Table 2. The results show that the factor loading of all indicators is above the recommended value of 0.70 [29, 32], which means that the indicators have good indicator reliability. In addition, Cronbach's alpha values are between 0.782 and 0.944 with composite reliability values between 0.859 and 0.953, both being greater than the recommended 0.70 [33, 50]. The findings highlighted the internal consistency and reliability of all constructs. Further, the AVE values are above the minimum threshold of 0.50 with values ranging from 0.604 to 0.729, showing satisfactory convergent validity [31, 34]. Therefore, the measurement model is acceptable with satisfactory reliability and validity, indicating that the measurement items are suitable for further structural model analysis, which is used to represent the constructs of the variables for analysis.

Heterotrait-monotrait ratio of correlations (HTMT) was used to test for discriminant validity which is shown in Table 3. Based on the recommendation of previous studies [28, 37], HTMT values lower than 0.90 are considered as having good discriminant validity between constructs. The results indicate that all HTMT values lie within the range of 0.558 – 0.846, which is less than the recommended threshold of 0.90. In particular, the highest value of HTMT is found between the variables "graphic calculators' quality" and "self-confidence" (0.846), and the lowest value of HTMT is found between the variables "computational quality" and "graphic calculators' quality" (0.558). None of the values are above the critical level, hence the results indicate that each construct is empirically different from the others, and each represents a different aspect of the conceptual framework.

Table 2: Reliability and Validity

Variable	Item	Loading	Alpha	CR	AVE
Access to Mathematical Content Quality	AMCQ1	0.751	0.782	0.859	0.604
	AMCQ2	0.752			
	AMCQ3	0.787			
	AMCQ4	0.817			
Business Decision Making	BDM1	0.692	0.845	0.897	0.686
	BDM2	0.867			
	BDM3	0.878			
	BDM4	0.862			
Computational Quality	CQ1	0.836	0.944	0.953	0.718
	CQ2	0.872			
	CQ3	0.868			
	CQ4	0.837			
	CQ5	0.848			
	CQ6	0.866			
	CQ7	0.869			
	CQ8	0.776			
Graphic Calculators Quality	GCQ1	0.726	0.94	0.947	0.619
	GCQ10	0.775			
	GCQ11	0.785			
	GCQ2	0.805			
	GCQ3	0.772			
	GCQ4	0.8			
	GCQ5	0.792			
	GCQ6	0.803			
	GCQ7	0.816			
	GCQ8	0.808			
Self-Confidence	GCQ9	0.77	0.926	0.942	0.729
	SC1	0.828			
	SC2	0.844			
	SC3	0.815			
	SC4	0.88			
	SC5	0.883			
	SC6	0.871			

Thus, the concept of discriminant validity is established which means that they could distinguish between computational quality, access to mathematical content quality, graphic calculators' quality, self-confidence, and BDM. Therefore, the measurement model meets the discriminant validity criteria.

Table 3: Heterotrait-Monotrait Ratio of Correlations (HTMT)

	AMCQ	BDM	CQ	GCQ	SC
Access to Mathematical Content Quality					
Business Decision Making	0.687				
Computational Quality	0.824	0.577			
Graphic Calculators Quality	0.84	0.846	0.558		
Self-Confidence	0.766	0.627	0.603	0.846	

The results of the structural model and hypothesis testing are presented in Figure 3 and Table 4. The findings show that computational quality has a positive effect on BDM ($\beta = 0.106$, $t = 2.339$, $p < 0.05$) which supports Hypothesis 1. Likewise, BDM is found to be positively influenced by access to mathematical content quality ($\beta = 0.251$, $t = 5.480$, $p < 0.001$); thus, supporting Hypothesis 2. The use of graphic calculators for BDM has the highest positive effect ($\beta = 0.637$, $t = 13.391$, $p < 0.001$) which supports Hypothesis 3. The results also show that BDM is significantly influenced by self-confidence ($\beta = 0.386$, $t = 8.206$, $p < 0.001$) which supports Hypothesis 4.

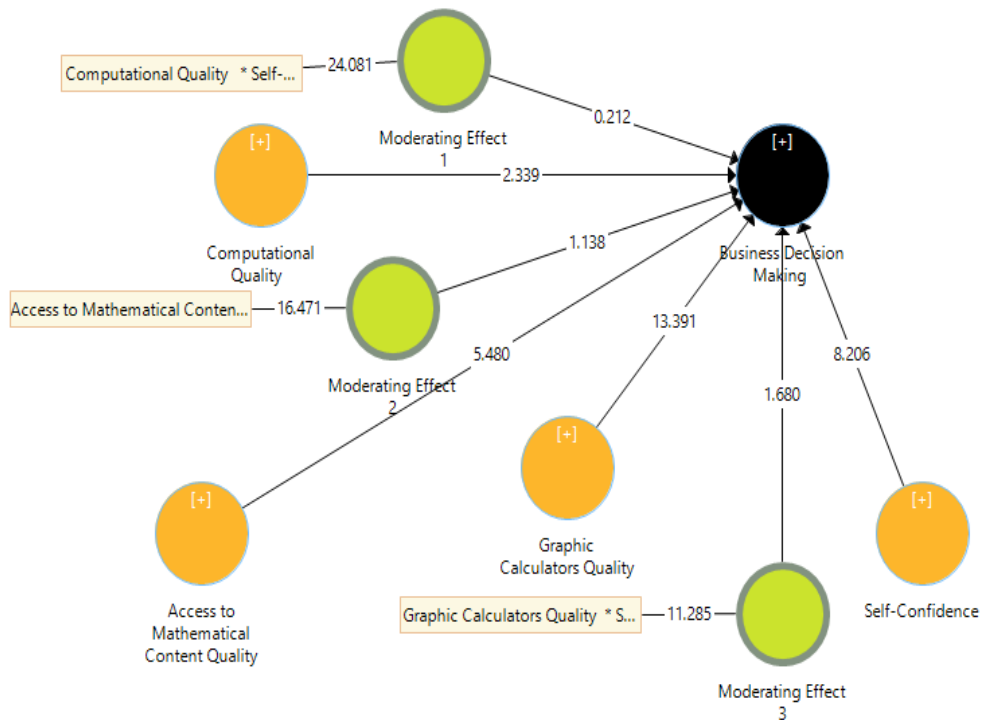


Figure 3: Path Analysis

Table 4: Results

Hypothesis	Beta Value	(STDE V)	T Value	P Values	Decision
Hypothesis 2: Access to Mathematical Content Quality -> Business Decision Making	0.251	0.046	5.48	0	Accepted
Hypothesis 1: Computational Quality -> Business Decision Making	0.106	0.045	2.339	0.01	Accepted
Hypothesis 3: Graphic Calculators Quality -> Business Decision Making	0.637	0.048	13.391	0	Accepted
Hypothesis 5: Moderating Effect 1 -> Business Decision Making	0.013	0.06	0.212	0.416	Not Accepted
Hypothesis 6: Moderating Effect 2 -> Business Decision Making	0.052	0.046	1.138	0.128	Not Accepted
Hypothesis 7: Moderating Effect 3 -> Business Decision Making	0.083	0.049	1.68	0.047	Accepted
Hypothesis 4: Self-Confidence -> Business Decision Making	0.386	0.047	8.206	0	Accepted

Moderating effect of self-confidence does not significantly moderate the relationship between computational quality and BDM ($\beta = 0.013$, $p > 0.05$) and access to mathematical content quality and BDM ($\beta = 0.052$, $p > 0.05$), accordingly Hypotheses 5 and 6 were rejected. The relationship between the quality of graphic calculators and BDM significantly moderated by self-confidence ($\beta = 0.083$, $t = 1.680$, $p < 0.05$), supporting Hypothesis 7. The findings indicate that the quality of graphic calculators is the most significant factor in affecting BDM while self-confidence positively affects the results of the decision making as the other factors act positively. The moderating role is further explained in the following Figure 4, showing that self-confidence strengthens the relationship between graphic calculators and BDM.

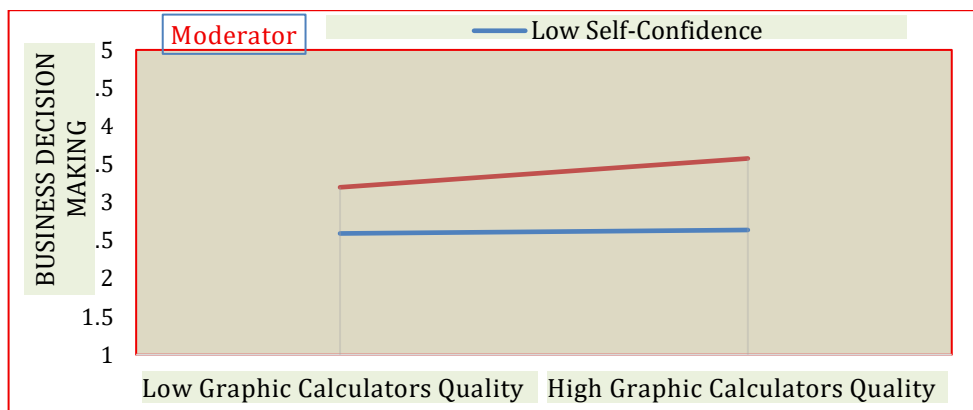


Figure 4: Moderation (Graphic Calculators Quality* Self-Confidence -> Business Decision Making)

Discussion and Conclusion

The main purpose of this study is to explore the effect of computational quality, access to mathematical content quality, quality of graphic calculators, and self-confidence moderation on BDM. The results offer important information on the

relationships between the various dimensions of mathematical application quality and decision effectiveness, as well as the impact of self-confidence on these relationships.

The results show that hypothesis 1 is accepted, which highlighted that computational quality is positively and significantly affecting business decisions. These results indicate that a well-designed computational function can lead to improved processing of information by users and provide reliable analytical results. Computational quality is an important aspect in effective decision making [10], because business decisions are often made through complex calculations, forecasting processes, and alternatives evaluation. Mathematical applications which provide accurate calculations and analytical information [52] can make the decision makers more likely to use information from the mathematical applications to make decisions. Thus, it enhances the quality of decision-making through accurate calculations. This result corroborates previous studies stressing the role of computational ability and mathematical applications in the improvement of the analytical thinking and problem-solving skills of business [36, 62].

The results also confirm Hypothesis 2, which suggests that access to mathematical content quality has a positive impact on BDM. The results show that the provision of mathematical information is important in the application to the user, which must be accurate, relevant, and complete. Analytical content of high quality enhances the understanding of the concepts and provides an opportunity to use mathematical reasoning in business contexts [9]. Access to reliable content allows people to make informed decisions through the assessment of options and awareness of the potential consequences of decisions [48]. The results indicate that mathematical applications are not just computational devices, but sources of knowledge which can be used for improving business decisions and business outcomes.

Hypothesis 3 is also supported and shows the strongest relationship among all the direct hypotheses in this study. The results show that the use of graphic calculators in BDM improves the quality of the results. These results are consistent with the previous studies highlighting the positive relationship between graphic calculators in business studies [17, 39]. Based on this outcome, visualization and graphical representation skills are important skills to support business analysis. Graphic calculators can be used to better identify trends, compare situations, and interpret complex information [66]. This suggests that decision makers are highly motivated toward tools that convert analytical information into more visual formats that are easier to comprehend and use. It also indicates that current BDM increasingly relies on technologies that further facilitate the visualization and interpretation of the data, and that graphic calculators play a significant part in the field of mathematical applications.

The results also support Hypothesis 4 and state that there is a positive correlation between self-confidence and BDM. This finding suggests that those who are more confident with their mathematical and analytical skills are more likely to make effective business decisions. Self-confidence is a positive trait that motivates people to think more deeply about issues, consider options carefully, and understand information [47, 70]. People who are confident decision makers are more likely to embrace the technology and tools for accuracy in decisions. As a result, self-confidence is one of the personal resources which directly influences the effectiveness of decision making. This result is consistent with past studies that indicated that increased confidence would lead to improved problem-solving, learning, and decision-making quality in an analytical setting [16, 40, 57].

Contrary to this, there is no support for Hypothesis 5 which suggested that

computational quality affects BDM, but this effect is moderated by the level of self-confidence. Although computational quality significantly influences BDM [8], the strength of this relationship does not vary according to respondents' confidence levels. The reason may be that the quality of the computation is mostly related to the quality of the application itself such as technical precision and efficiency. Computational systems with high quality give reliable answers [19, 51], no matter how confident the user is. Therefore, even people with less confidence can use computational functions, as much of the analysis is done automatically. This has led to a situation where self-confidence might not always be essential for the quality of computing to be reflected in the quality of decision making for a business.

Likewise, Hypothesis 6 was not supported, which suggests that there is no significant moderation effect between access to mathematical content quality and BDM by self-confidence. This finding indicates that users do not differ significantly from each other in their benefit from high quality mathematical content, as a function of confidence level. Content that is well structured and accessible can have sufficient clarity and informativeness to facilitate decision making without having to have a high level of confidence. Additionally, having a good supply of quality content could decrease uncertainty [49, 69] and help users to grasp the concepts of analysis, which in turn would lessen the impact of different individual levels of uncertainty. Therefore, the relation between the quality of mathematical content in textbooks and BDM seems relatively consistent for the different respondents according to self-confidence in mathematics.

The results support Hypothesis 7 that states self-confidence is a moderator between the graphic calculator's quality and the BDM. The result suggests that the higher self-confidence of the users, the better the effect of using graphic calculator quality. Graphic calculators tend to involve using the graphic display to interpret the information, exploring alternative ways of analysis, and working with the graphical output. Graphic calculators can involve the student in interpreting the information on the graph [58, 67], exploring other approaches to the analysis and working with the output. Users with high self-confidence are more likely to be able to understand and use these advanced features and can make use of visualization to gain useful information. The relationship between graphic calculators' quality and BDM is also stronger for respondents who have high levels of self-confidence in comparison to those who have low levels of self-confidence. As a result, users' confidence increases and they can gain the maximum benefits from graphical and visualization technologies.

Finally, it shows that computational quality, access to mathematical content quality, graphic calculators' quality, and self-confidence have an impact on BDM. Of these, the quality of the graphic calculators is the best predictor of decision effectiveness. The results also show that self-confidence directly affects BDM and the effect of the quality of graphic calculators on BDM is also strengthened. However, the impact of computational quality and access to mathematical content quality is not significantly different with higher self-confidence. In general, it reveals the need for using good mathematical applications and users' confidence to support BDM that is more accurate, reliable, and effective. The findings add to the existing knowledge on the interaction between technological and psychological variables and the performance of decision making in modern business settings.

Implications

This study enriches the existing literature related to BDM by combining variables: computational quality, access to mathematical content quality, graphic calculators' quality and self-confidence, in one framework. This study shows how both technological and psychological aspects influence decision-making together. The results also confirm the validity of Technology Acceptance Model (TAM) in the explanation of the role of mathematical applications in business environments. Furthermore, the moderation of self-confidence on the relationship between graphic calculators' quality and BDM gives further insights into where the technologic tools create greater value.

In practice the results imply that more investment should be made in the quality of the mathematical applications used, especially in the use of graphic calculators and visualization products, to enhance the quality of decision making in organizations. Software developers are given priority to improve the computational accuracy, accessibility of content and graphical functions to meet the analytical needs of the users. In addition, training and development should be provided to boost employees' self-confidence in using mathematical applications. By improving technological capabilities and user confidence, organizations can be better able to make accurate, reliable and data-driven business decisions.

Future Recommendations

Future studies should augment the existing framework with other technological and behavioral factors that can influence BDM including perceived usefulness, technology readiness, analytical skills, and digital literacy. Researchers can also explore intervening processes that link the use of mathematics to a decision-making process. This study used cross-sectional design and convenience sampling techniques; therefore, future studies could incorporate probability sampling techniques and longitudinal design to improve the generalizability and the causality of the findings. Comparative research across industries and organizational contexts can yield greater understanding of contextual variations. In addition, future studies could investigate the use of more sophisticated analytical tools, such as artificial intelligence and predictive analytics, and how these new technologies relate to mathematical applications and self-confidence and their influence on the effectiveness of decision making in business.

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