



# The role of data visualization and analytics in performance management: Guiding entrepreneurial growth decisions

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## ABSTRACT

This case introduces you to a small but growing e-commerce venture and asks you to assume the role of an accountant tasked with designing a performance management system that aligns with the venture's growth objectives. Using a sample of actual customer, order, and revenue data, you are guided to develop visualizations in Excel and Tableau and communicate your findings. Finally, the case challenges you to map business problems with analytical techniques such as regression, decision trees, and clustering in order to prioritize activities and manage the growth the company has experienced to date. The case addresses a growing need for accountants to develop competency in predictive analytics (PWC, 2015).

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## 1. Introduction

The goal of most companies, whether a startup or a large multinational corporation, is to grow net income by increasing revenues. It is logical to think that in order to grow, a company should pursue revenue opportunities from any source possible. However, most successful companies focus their growth efforts in areas where they have built their distinctive capabilities; strengths that set them apart from everyone else (Leinwand & Mainardi, 2016). To make sound strategic growth decisions, companies must establish a coherent performance management system that includes critical metrics that support a company's value proposition. To do so, companies must find ways to select, validate, and prioritize performance measures.

This project gives you hands-on experience with analytics and performance management in an e-commerce venture. This project also challenges you to think of ways to incorporate financial and non-financial data to guide the venture at a critical time in its evolution as it attempts to thrive and grow. This case is unique as it highlights the interdisciplinary nature of running a company where analytics help create a performance management system that informs strategic growth decisions.

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### 1.1. Background: data and analytics

Data and analytics are critical components of successful performance measurement and management for growth. A company's operations and interactions with customers are constant generators of data that are often rich with information. However, the abundance of data and plethora of data sources are also responsible for many challenges faced by companies trying to drive decisions based on data. For example, some data are *structured* – stored in rows and columns in spreadsheets or in relational databases – and are easy to retrieve and analyze. Other data – such as email data or website traffic data – are referred to as *semi-structured* and require more effort to process and summarize in useful ways. Finally, there is often a wealth of *unstructured* data associated with a company – customer comments, reviews, testimonials; social media discussions and references; customer service call transcripts. Storing, retrieving, and managing all different types of data, as well as prioritizing performance measures based on these data to help a company grow are complex problems faced by many companies today.

Tracking performance via performance measures is an example of *descriptive* and *diagnostic* analytics; one can obtain information about how the company is doing and diagnose potential issues. Many companies have grown to appreciate the importance of employing various types of analytical techniques to move from the descriptive and diagnostic to predictive and prescriptive (see, for example, Kiron, Prentice, & Ferguson, 2014; Parr-Rud, 2012). *Predictive* analytics involve employing complex analysis based on statistical, data mining, and machine learning techniques to detect relationships and make predictions about the future or about categories of data that are not available (such as what type of customer would find a product appealing). *Prescriptive* analytics go a step beyond and use modeling to make recommendations about the best course of action given the predictions made; such as how to schedule sales representatives given predicted demand for goods and/or services.

Accountants often play central roles in supplying senior management with timely and reliable information to inform crucial strategic decision-making activities. Accountants, therefore, have the opportunity to be at the forefront of analytics implementation in their companies. A necessary step toward accomplishing this goal is for accountants to achieve competency in the analytical techniques that take advantage of data from multiple sources and of multiple types – structured, semi-structured, unstructured, big and small.

### 1.2. The business life cycle

Bombas, the startup in this case, is an early stage company that is in need of the advice from an “analytics-savvy” accountant. It is just a couple of years old and has been quite successful to date. Bombas has survived the difficult first stages of development and now has a handful of products that it has sold to over one hundred thousand customers in just the two-and-a-half years it has been in business. Fig. 1 contains the classic life cycle depiction which can be used to illustrate either the life cycle of an individual product or the life cycle of a business. During the introduction stage, companies are focused on trying to acquire the resources needed to get started and develop the necessary technical capabilities to get into the marketplace. Next, as companies begin to grow, they have to overcome issues related to commercialization: the production and scaling of their products and the business as a whole. As growth accelerates and the venture begins to move toward maturity and stability, companies struggle with issues such as sales volumes, market share, profitability, internal controls, and where their future growth will come from.

While the success Bombas has enjoyed is admirable, it now faces the challenge of stabilizing and growing the company. The company is currently in the growth phase and is managing the myriad issues that come as a startup attempts to scale. Top management relies on you as their accountant to assist in the analysis of data and to provide advice. Data and analytics can be used to prioritize activities and manage the growth the company has experienced to date. This case provides you with

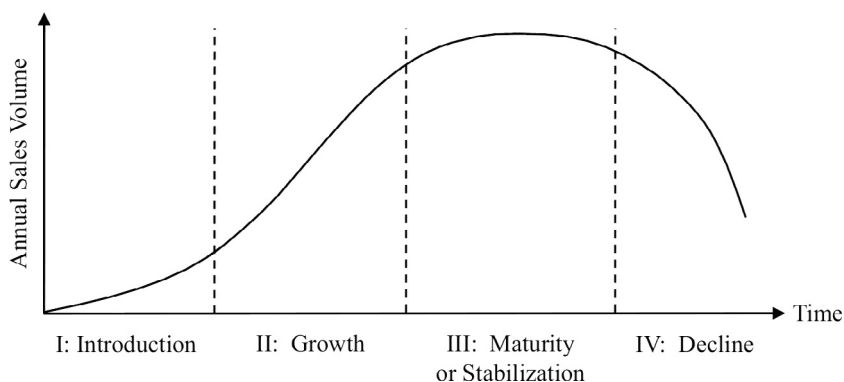


Fig. 1. Lifecycle of a product (or business) (adapted from Levitt (1965)).

actual revenue data to develop and deploy analytical techniques to guide the continued success of a new venture in order to avoid the natural progression toward decline.

## 2. Scenario

After graduating from the top entrepreneurship college in the US, brothers Andrew and David were eager to begin their journeys as entrepreneurs. Their goal was to establish a company that would be both profitable and help those in need. After learning that socks were the most requested item in homeless shelters across the US, their idea for an online athletic and leisure sock company with a social mission was born. Along with their two other co-founders, they named their company Bombas and spent two years on research and development to engineer a sock that was built for both athletic performance and extreme comfort; a sock that looked and felt better than any other sock on the market. The Bombas business model is similar to the business models of companies like Toms and Warby Parker – for each pair of socks sold, one pair is donated to homeless shelters across the country.

After finalizing the design, the co-founders launched a crowdfunding campaign on indiegogo.com in August of 2013. Bombas remains the #1 most funded apparel campaign on the platform to date, with \$142,488 raised in purchase commitments by 2751 people in one month.<sup>1</sup>

Bombas' original and primary product has seven unique features: long staple, combed pima cotton, performance footbed, stay-up technology, blister tab, y-stitched heel, honeycomb support system, and invisitoe. Since its initial product launch, Bombas has continued to innovate, design and offer a number of different styles, colors and materials. Socks are Bombas' only product, and they are sold exclusively online at bombas.com. Most pairs of socks currently retail for \$12, with specialty products reaching \$18 per pair. To date, Bombas has donated more than one million pairs of socks to those in need.

Bombas has enjoyed great success with its products; it has seen a consistent increase in new customers and has an extensive social media following. The founders are seeking the advice of management accountants. The Bombas leadership needs help understanding revenue and order data, increasing repeat customer rates, optimizing website use, and spending on marketing.

## 3. Software and data

You will use Excel and Tableau to develop analytics solutions for Bombas' revenue data. Your instructor will provide you with an Excel workbook titled "BombasRevenueData.xlsx" containing a random sample of 1100 customer orders. You will use this dataset to complete the case requirements.

Visualization software Tableau's website, <http://tableausoftware.com>, has a number of training resources. As part of the preparation for the case, you can watch the first few videos at <http://www.tableau.com/learn/training>. (For example, the first lesson in each of the groups of videos Getting Started, Connecting to Data, Visual Analytics, Dashboards and Stories, and Mapping are a good place to start.) These videos demonstrate how to create a time series graph, a geographic visualization, as well as a performance dashboard which will be useful as you complete this project.

## 4. Requirements

Assume you are a management accountant who is tasked by Bombas' founders to use analytics and develop tools that would help a cash-strapped e-commerce startup grow revenue. Perform the steps outlined below to complete this project:

1. Take a tour of Bombas' website at bombas.com and watch the Indiegogo campaign at <https://www.indiegogo.com/projects/bombas-better-socks-better-world-bee-better#/> to learn about the company. Familiarize yourself with Bombas' social media presence by visiting Bombas on Facebook and Instagram. What are your initial impressions about the company? What are some of the challenges the company might be facing? Who are Bombas' customers?
2. Read [Appendix A](#) and perform the step-by-step guidelines for analytics applications for Bombas' revenue data using Excel (pivot tables, time series graphs, heatmaps, and correlation analysis) and Tableau (geographic visualizations and performance dashboards).
3. Interpret the Excel and Tableau output you generated. What recommendations would you make to Bombas's founders regarding its: customer location, behavior on the website, order patterns and revenues? When should Bombas schedule the work hours of its customer service representatives? Where should Bombas target its future advertising campaigns?
4. Read [Appendix B](#) and think of ways for Bombas to measure its performance over time using the Balanced Scorecard approach. [Table 1](#) presents an incomplete Balanced Scorecard that Bombas is using. Your task is to recommend 2–3 more measures and metrics to Bombas founders for each scorecard category: learning and growth, internal process, customer, and financial.
5. What kind of data would you need for the metrics you recommend to Bombas? Are the data structured, semi-structured, unstructured? (To answer this question, feel free to use external information from various online sources.)

<sup>1</sup> The full indiegogo campaign is available at <https://www.indiegogo.com/projects/bombas-better-socks-better-world-bee-better#/>.

**Table 1**  
Incomplete balanced scorecard.

Perspective	Strategy Pursued	Measure	Metric
Financial	Increase revenue	Revenue growth	Revenue increase/revenue last period
Customer	Acquire and retain customers	Customer Lifetime Value <sup>a</sup>	Average sale per customer × number of sales per customer yearly × average retention time
		Cost per Acquisition	Acquisition spend/number of conversions
Internal Process	Achieve timely delivery of product at a reasonable cost	Shipping Cost Relative to Total Revenue	Shipping cost/total revenue
Learning and Growth	Learn how to create a customer-focused culture	Maximize Loyalty	Change in Net Promoter Score <sup>b</sup>
	Create innovative products	Gain customer insight on new product creation	Analysis of focus groups, social media, bloggers, influencers

<sup>a</sup> Customer Lifetime Value (CLV) is the predicted revenue a customer will realize for the company over the lifetime of the customer's relationship with the company. The measure has been adapted from <https://www.quora.com/What-are-the-key-KPIs-to-track-for-a-consumer-internet-startup>. For more ways to calculate CLV, refer to <https://blog.kissmetrics.com/how-to-calculate-lifetime-value/>.

<sup>b</sup> Net Promoter Score (NPS) is a measure of company's performance through customer lens. Customers are asked the following question: "How likely is it you would recommend us to a friend?" on a scale from 0 to 10. If a customer responds with 10 or 9, that customer is considered a "promoter"; if 8 or 7, that customer is a "passive"; if between 0 and 6, the customer is a "detractor". The NPS is computed by subtracting the percentage of detractors from the percentage of promoters (Bain, 2016).

- Read [Appendix C](#). Keeping in mind the Balanced Scorecard you just designed, what are some of the advanced analytical techniques you could use to help Bombas?
- Present your findings in a brief PowerPoint presentation for the startup founders. Outline your recommendations and the tools you have used to generate those recommendations. Your deliverable must include your output from Excel and Tableau.

## 5. Teaching notes

### 5.1. Motivation and learning objectives

In a 2015 report based on results from a survey of over 1300 CEOs in more than 60 countries, PwC argued that, "Universities should infuse analytical exercises into existing curriculum to help students develop data analytics proficiency on top of their core accounting skills" (PwC, 2015, 14). PwC also pointed out the growing need not only for "skills for technical problem-solving, but also on problem-framing, so students learn to ask the right questions and think strategically" (PwC, 2015, 1). This case helps develop analytics-related and problem-framing skills indicated by PwC and other major accounting service providers as necessary for university graduates to succeed in the current business environment. It is also motivated by the need for accounting programs in the US to integrate modern accounting and business technology to enable the development of data analytics skills (AACSB, 2013).

The case introduces students to the process of developing logical accounting analytics solutions to address specific business issues. Moreover, the case is based on real company data and presents issues relevant to many companies today. The case focuses on the following analytics-related skills:

- Identifying key business issues at a particular growth stage for a company (Requirement 1).
- Developing data visualizations in Excel and Tableau to glean insights from revenue data (Requirement 2).
- Interpreting the results and recommending a course of action (Requirement 3).
- Determining appropriate metrics to track performance, diagnose problems, and look for solutions (Requirement 4 and 5).
- Matching the business issues with most suitable predictive analytics solutions (Requirement 6).
- Communicating the findings in a manner tailored to the receiving audience (Requirement 7).

### 5.2. Course use and student prerequisites

This case can be used with software packages like Excel and Tableau. Students are provided with specific examples of analytics solutions in the Appendices. The case can be incorporated in managerial accounting courses at both the undergraduate and the graduate levels to facilitate a richer discussion of data-driven performance measurement and management. Specifically, it can be introduced when covering balanced scorecards and strategy maps. Another successful use of this case could be in a course that introduces students to accounting analytics, such as a course in accounting information systems or auditing. The case can be taught in conjunction with Janvrin, Raschke, and Dilla (2014) or Igou and Coe (2016). The only prerequisite for the case is basic competency in Excel. In our experience, students learn Tableau quickly through the instructional videos available on the software provider's website.

### 5.3. Implementation guidance

To implement this case, students first need to become familiar with the case scenario and get to know Bombas as a company by watching its Indiegogo campaign video online. Subsequently, the students review and graph the Bombas transactional data presented in the Excel spreadsheet. For example, students may use a heatmap from the initial analysis to visualize the times of the day and the week when the most orders are placed. This can inform marketing campaign decisions or operational decisions related to staffing of customer service representatives. Students may also use a map visualization to summarize information about customer locations (Who is Bombas reaching?), the order activity in different geographical areas (What areas should be targeted in the future?), and product preferences for different geographical areas (How much of different products should be stocked in different locations?).

After viewing the data and acquainting themselves with the company, students should read the background information on strategic performance measurement in [Appendix B](#). [Appendix B](#) reviews the four important perspectives in building a strategy map for a company: the financial perspective, the customer perspective, the internal process perspective, and the learning and growth perspective. It also summarizes some important metrics used to measure performance from each of these perspectives. The instructor could discuss these metrics with students and solicit input on additional metrics that Bombas may want to consider.

While most accounting fundamentals discussions would stop at this point, a data analytics-centric discussion would cover the following additional issues that are likely to be challenging in practice:

1. What kind of data would Bombas need to compute the metrics designed as part of the balanced scorecard? Where would the data come from, and how would the data be stored and retrieved regularly for analysis purposes?
2. What kind of performance metric visual displays would be helpful for decision making?
3. Are these performance metrics sufficient for understanding the leading indicators of performance?

The performance metrics described in [Appendix B](#) should be tracked on a periodic basis, and the graphs in [Appendix A](#) represent examples of visualizations that can be used. For example, the time series of a financial metric such as increase in the number of orders over the previous period could be plotted to monitor order growth.

Item 3 in the list above leads to a discussion about applications of advanced analytical techniques: the observation of relationships and the discovery of deeper insights. One possible direction of discussion could be at the aggregate level; the study of correlations and the use of predictive models such as regression to find out if a particular metric such as number of page views correlates with an increase in the number of orders placed by a customer.

Another possible direction of discussion is at the individual customer level. Bombas could apply advanced analytical techniques to understand its customers better. For example, Bombas could use regression techniques to estimate a particular customer's lifetime value (Bombas is already estimating this value through an external vendor). Cluster analysis can be used to identify groups of customers who have similar behavior or demographics. If data were available on the actual cost of each pair of socks a customer purchases, the cost of shipping (if the order met the minimum for free shipping), and coupon discounts, one could estimate the total cost of the customer. Subtracting the total cost from the sales price of the order would determine profitability of each customer. One could request this additional data and then determine if customer profitability was associated with particular types of customer behaviors.

Finally, one may request additional data to discuss product profitability and bundling. Association rules (also called market basket analysis) could be used to determine if socks of certain colors or types were purchased together, which could inform product bundling and new product decisions.

The advanced analytics discussion can be guided by [Table 4](#) in [Appendix C](#), which summarizes types of business questions that can be answered with some common advanced analytical techniques. The instructor could start with the balanced scorecard ([Table 1](#)) as a foundation for the discussion. Specifically, once students have identified metrics that are important for company growth, the instructor could ask how these metrics could be improved. If Bombas' goal is to increase average Customer Lifetime Value (in the Customer category), for example, then decision trees or regression could be used to identify characteristics that determine the Customer Lifetime Value, and the results could be used to design marketing campaigns that target customers with the desired characteristics. If Bombas' goal is to increase Email Click Rate (in the Customer category), then text analytics can be used to identify the most effective wording for emails, and logistic regression and decision trees can be used to identify customers most likely to click on the email, so that the targeting can be effective. Sentiment analysis on social media data can be used to calculate the Customer Satisfaction Score identified in the Learning and Growth section of the strategy map.

### 5.4. Scoring criteria and sample solution

We suggest to include the following items in developing a scoring criteria to evaluate student performance:

- The number and appropriateness of metrics suggested by the students that Bombas can use for performance evaluation.
- Whether the appropriate formats and visualizations are used to illustrate metrics and results from the application of analytical techniques.

- Whether the presentation informs a decision maker enough so that the recommendations can be used to pursue a data-driven growth strategy.
- Whether the student could suggest additional advanced analytical techniques that help uncover additional relationships in the data and drive a deeper understanding of the company and its performance.

### 5.5. Evidence of efficacy

We collected efficacy data for two classes of an undergraduate managerial accounting course in a private college. The instructor was one of the authors. Descriptive statistics for the class profile are presented in Panel A of Table 2. Panel B of Table 2 summarizes the students' competency in spreadsheet and visualization software prior to the case.

The case was presented at the end of the semester in two 75-minute sessions. The first session began with a discussion on performance management in the context of sustainability. In the last 25 minutes of the first session, the students watched the Shark Tank video (Season 6, Episode 1, released on September 26, 2014) and were introduced to the case and the assignment. They were then asked to complete Requirements 1–3 of the case before the following class.

**Table 2**  
Descriptive statistics and efficacy data.

Panel A: Descriptive statistics		Pre-Case	Post-Case		
Gender					
Male		42 (58.33%)	30 (50.85%)		
Female		30 (41.67%)	29 (49.15%)		
Average Age		19	19		
Class standing					
Freshman		0 (0%)	1 (1.69%)		
Sophomore		65 (90.28%)	53 (89.83%)		
Junior		6 (8.33%)	4 (6.79%)		
Senior		1 (1.39%)	1 (1.69%)		
Panel B: Student familiarity with spreadsheet and visualization software packages before the case					
Current estimated level of knowledge of analytics software	MS Excel	Tableau or other advanced visualization package	Advanced data analytics and statistical modeling software such as R, Minitab, SPSS, SAS		
None	4 (5.56%)	42 (58.33%)	10 (13.89%)		
Beginner	12 (16.66%)	20 (27.78%)	40 (55.56%)		
Intermediate	45 (62.50%)	9 (12.50%)	19 (26.39%)		
Advanced	11 (15.28%)	1 (1.39%)	3 (4.16%)		
Panel C: Results of pre-case and post-case surveys <sup>a</sup>					
Statement	Pre n	Post n	Pre mean (SD)	Post mean (SD)	Significance
1. I understand how data analytics can be used to answer important business questions	72	59	4.4028 (0.5972)	4.5932 (0.5607)	p = 0.0643 <sup>*</sup>
2. I understand how to use data visualization tools to explore data for business insights	72	59	4.0833 (0.6446)	4.4068 (0.5607)	p = 0.0030 <sup>**</sup>
3. I understand how advanced analytics techniques can be used to determine relationships in data and to predict behaviors	72	59	4.1667 (0.6713)	4.3390 (0.6594)	p = 0.1431
4. I understand how to evaluate both financial and non-financial aspects of business performance	72	59	4.1944 (0.5474)	4.2712 (0.6652)	p = 0.4701
5. I understand how to create performance metrics that are aligned with the pursued strategy	72	59	3.8333 (0.5814)	4.3051 (0.6500)	p < 0.0001 <sup>***</sup>
Panel D: Results of debriefing questionnaire					
Statement	Mean (SD) (n = 52)			Significance (Difference from Neutral (3))	
1. I found the case to be engaging and interesting	4.0680 (1.0150)			p < 0.0001 <sup>***</sup>	
2. I found the case to be an effective way to gain an understanding of how data analytics can be used to answer important business questions	4.1017 (0.9772)			p < 0.0001 <sup>***</sup>	
3. I found the case to be an effective way to gain an understanding of data analytics software	3.8140 (1.1370)			p < 0.0001 <sup>***</sup>	
4. I found the case to be an effective way to develop skills and knowledge related to data analytics from an accountant's perspective	4.0339 (0.9462)			p < 0.0001 <sup>***</sup>	
5. I think that this case should be used in future classes	4.1690 (1.0850)			p < 0.0001 <sup>***</sup>	

Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree.

<sup>a</sup> Due to time constraints, not all students completed the post-survey.

<sup>\*</sup> Significant at the 10% significance level.

<sup>\*\*</sup> Significant at the 5% significance level.

<sup>\*\*\*</sup> Significant at the 1% significance level.



The following class started with the Beyond the Tank video (Season 2, Episode 14, released on May 15, 2016) followed by a discussion of the visualizations created by the students (a total of 20 minutes). The students were then asked to work in groups for 15–20 minutes to develop strategies and metrics for Bombas performance management, keeping in mind the interpretation of the visualizations. To wrap up the class, in the remaining 30 min each group was asked to share their findings with their classmates.

To assess the efficacy of this case, we developed a questionnaire with five statements related to the case learning objectives. Students were asked anonymously to indicate the level of agreement or disagreement with each statement before and after the case. We used a five-point Likert scale where 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, and 5 = Strongly agree. Pre-case and post-case results are presented in Panel C, Table 2.

The results of this questionnaire show a statistically significant improvement with regard to the students' perceptions of the primary objectives of the case: creating performance metrics that are aligned with the pursued strategy and understanding of how to use visualization tools to explore data for business insights (Questions 2 and 5 in Panel C, Table 2). Students also gained an understanding of how data visualization and more advanced analytics can be used to answer business questions (Questions 1 and 3). The results for Question 4 do not seem to indicate statistically significant improvement; however, it should be noted that during the first session and before the pre-case survey was conducted, students were exposed to non-financial metric evaluation as part of the sustainability discussion. Thus, the insignificant change between the first and the second class session may be reflective of the fact that they already felt knowledgeable in this area. (The average pre-case score on that question was 4.19 out of 5.) It should be noted also that by their sophomore year, undergraduate students at the authors' institution have taken at least two courses in analytics and modeling, and that may explain the comfort of the class with applications of visualization and modeling techniques both in the pre-case and post-case survey. The results from the pre- and post-case surveys indicate, however, that the case is effective at providing a context in which the students in the class can appreciate the application of analytical techniques (Questions 1, 2 and 5).

We also assessed the students' overall impressions of the case by conducting a short debriefing questionnaire adopted from Igou and Coe (2016). The results of this questionnaire (see Panel D, Table 2) demonstrate that the students had a positive experience with the case and would like to see it used in future classes.

To assess student learning, we created a mapping exercise as shown in Panel A, Table 3. (Possible answers to the mapping exercise are shown in the solutions file.) Panel B of Table 3 shows the results of a pre- and post-case survey of learning outcomes. The students in the class were asked anonymously to answer questions about the most appropriate analytical technique to use to answer a particular business question. The p-values for the statistical tests conducted on the significance of

**Table 3**  
Mapping exercise and its results.

Panel A: Mapping exercise					
	Scatterplot	Pivot (contingency) table	Time series plot	Map visualization	Numeric summaries (Means, correlations, etc.)
Analyze the frequency of orders over a period of time					
Summarize number of orders placed by time of day					
Determine if some geographical areas have a higher number of orders than others					
Determine if the size of a customer's order is related to the amount of discount offered					
Explore if repeat customers have characteristics that single-time customers do not					
Panel B: Pre-case and post-case results of the mapping exercise					
	Pre-Case (% Students Who Answered Correctly, n = 72)		Post-Case (% Students Who Answered Correctly, n = 59)		Significance
Analyze the frequency of orders over a period of time	62.50%		79.66%		p = 0.0270**
Summarize number of orders placed by time of day	65.28%		76.27%		p = 0.1630
Determine if some geographical areas have a higher number of orders than others	81.95%		94.91%		p = 0.0160**
Determine if the size of a customer's order is related to the amount of discount offered	83.34%		81.36%		p = 0.7860
Explore if repeat customers have characteristics that single-time customers do not	30.55%		45.76%		p = 0.0720*

\* Significant at the 10% significance level.

\*\* Significant at the 5% significance level.

\*\*\* Significant at the 1% significance level.

**Table 4**

Map of business problems and analytical techniques.

Type of problem	Analytical technique	What the analytical technique does
Determine the impact of one or more factors on an output variable of interest	Regression	Calculates an equation that links the values of inputs to the value of the output variable, so that one can predict the value of the output variable based on the values of the inputs
Determine the factors affecting an output variable and display them in order of importance	Decision Trees	Calculates rules starting with the most important input variable that allow one to predict the value of the output variable
Group items by similarity	Clustering	Places items into clusters based on measures of similarity or distance between the items
Determine if groups of items occur together in customer purchase transactions	Association Rules (Market Basket Analysis)	Based on how often groups of items occur together and how often subsets of these items occur when a particular group occurs, creates rules that, for example, allow one to determine whether customers have a high likelihood of buying one or more additional items given what is in their shopping cart so far, or what types of items are often purchased together
Extract information from unstructured (text) data	Text Analytics	Analysis of text to identify key words and phrases that help predict an output variable of interest or summarize a sentiment (see also Sentiment Analysis)
Extract information about customer opinion from text (blogs, comments, etc.)	Sentiment Analysis	Analysis of text with the goal of extracting information about the sentiment expressed in the text. The result is usually a report on whether the sentiment in a piece of text is positive, neutral, or negative, based on the occurrence of expressions deemed useful for identifying the sentiment

the difference in proportion of students who answered the question correctly before and after the case are provided. As the results in Panel B, [Table 3](#) illustrate, the case was effective in teaching students how to map analytical techniques to business questions.

An abbreviated version of this case was also implemented in a graduate managerial accounting course, with one of the authors as an instructor. Twenty-two students participated in this case and were asked to assess briefly their experience with the case. Eighty-seven percent of the students expressed agreement that the case prompted them to learn more about applications of data visualization and that the case increased their level of understanding of data-driven performance measurement. Ninety-five percent of participants agreed that the case prompted them to think about meaningful ways to visualize information.

### 5.6. Case extensions

The case of Bombas and its associated data provide instructors an opportunity to teach students about an important stage in a company's evolution. The case can be extended to a discussion of analytical performance management which examines statistical relationships between financial and nonfinancial metrics ([Davenport, 2008](#)). A discussion could address how regression modeling and the analytical hierarchy process ([Campbell & Lu, 2010](#)) could be implemented to prioritize performance metrics.

The case can also be extended to provide a glimpse into how the advice and counsel of accountants assist top managers in numerous business decisions across different functions. The data in the case can help students understand how they can use sales data to inform the company about production-related issues.

Entrepreneurial ventures at this stage of development need to grow market share and find a future base for growth. Data provided in the case can help the venture with growth decisions such as: where to spend ad dollars, which customers are most profitable, which products are most profitable, are certain regions more or less likely to generate sales, and more.

## 6. Case solution and Excel data

The solution and the spreadsheet with the order data are available upon request from the corresponding author.

## 7. Conclusion

There is a growing need for accountants to incorporate various types of data and analytics to inform strategic decision-making of management. This case introduces accounting students to data-driven performance management in the context of a rapidly growing new venture. Students are asked to identify strategic objectives for the venture and design a balanced scorecard with specific leading and lagging measures and metrics. Using a sample of the venture's actual customer, order, and revenue data, the case provides a hands-on experience with descriptive and diagnostic analytics using visualization. It then provides a context for discussing more sophisticated statistical analytics techniques such as regression, decision trees, and cluster analysis. The case can be completed using Excel and Tableau. Preliminary feedback suggests that this case achieves its goal of helping students understand the role of accountants in using analytics to guide performance management decisions.



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## Appendix A. Guidelines for performing analytics in Excel and Tableau

This appendix contains step-by-step guidelines for implementing visualizations and obtaining insight from Bombas' revenue data. While most students are familiar with Excel, they may be less familiar with Tableau. However, it is a relatively simple and intuitive program and we encourage students to just begin using it. They will feel comfortable with it in a matter of minutes.

To perform these analyses, use the data file titled *BombasRevenueData.xlsx*. The file contains the following columns: Customer number, State, Zip code, Registration date, Last site visit, Number of site visits, Number of product page views, Number of add to cart events, Number of checkout events, Number of orders placed, Number of items purchased, Order 1 revenue, and Order 1 purchase date.

As you work with the data, please answer the following question and then map each business question to the most appropriate analytics technique (refer to Panel A, [Table 3](#)):

What variables in the case dataset do you think would be helpful to analyze to identify key business issues Bombas is facing at this growth stage?

Visualize the frequency of orders placed during a time period.

- This could be accomplished by creating a time series graph in Excel.
- Transform "Order 1 purchase date" (this column includes the time of purchase along with month, date, and year) into "Order 1 MMDDYYYY" in order to create a count of orders by day. To do so, create a new column and use the following formula: `=DATE(YEAR(M2),MONTH(M2),DAY(M2))`, where Column M is "Order 1 purchase date".
- Create a PivotTable by clicking *Insert, PivotTable*. Make sure the option to create a *New Worksheet* is selected. Drag the newly created field "Order 1 MMDDYYYY" to the area under "ROWS". Then drag the same field "Order 1 MMDDYYYY" to the area under " $\sum$  VALUES".
- To create a time series graph, click on *Insert, Line Chart*. Select the first line chart to the left under the *2-D Line*.

Summarize the frequency of occurrence of a specific number of orders placed by individual customer for the duration of the time period in the data set.

- This could be done using a pivot table.
- Create a PivotTable by clicking *Insert, PivotTable*. Make sure the option to create a *New Worksheet* is selected. Drag the field "Number of Orders Placed" to the area under "ROWS". Then drag "Number of Orders Placed" to the area under " $\sum$  VALUES". Finally, click on the button "Sum of Number of Orders Placed" under " $\sum$  VALUES" and select "Value Field Setting," then "Count."

Visualize the frequency of orders placed by the day of the week and the time of the day.

- This could be done using a heatmap in Excel.
- Create a new column titled "WEEKDAY" by using the following formula: `=WEEKDAY(N2,1)`, where "N2" is "Order 1 purchase date" column and "1" is to indicate that the week begins with Sunday (1) and ends with Saturday (7).
- Create a new column titled "HOUR" by using the following formula: `=HOUR(N2)`, where "N2" is "Order 1 purchase date" column.
- Create a PivotTable by clicking *Insert, PivotTable*. Make sure the option to create a *New Worksheet* is selected. Drag the newly created field "WEEKDAY" to the area under "ROWS". Then drag the newly created field "HOUR" to the area under "COLUMNS". Finally, drag "Order 1 MMDDYYYY" to the area under " $\sum$  VALUES".
- Under the "Home" tab, highlight the area with order frequencies (excluding the Grant Total column), click on "Conditional Formatting", then "Color Scales", and select the first option on the left (Green – Yellow – Red Color Scale).

Determine the strength of the relationship between two variables.

- This could be done by running a correlation analysis in Excel.
- Under the "Data" tab, click on "Data Analysis." (If you do not see "Data Analysis" as an option in the "Data" ribbon, click on File, then "Options," then "Add-Ins," and select "Data Analysis Toolpak.") From the list of analytical techniques, select "Correlations." Select the two columns of numbers for which you would like to find the correlation. Click OK. Alternatively, one can use the CORREL formula in Excel.

=CORREL(Array Reference in Column 1, Array Reference in Column 2)

will return the correlation between the arrays in Column 1 and Column 2.

- It is always helpful to use a scatterplot to visualize the correlation. In the “Charts” section under the “Insert” tab, select “Scatter,” and then select the two columns to be plotted. (If the two columns with data are highlighted in advance, the scatterplot will appear automatically. Press the Ctrl key to highlight two non-contiguous arrays of data.)

Visualizations with Tableau can help look into additional issues. Some of these visualizations can be done with Excel as well; however, it takes more steps to do so.

Visualizations with Tableau:

Visualization software Tableau's website, <http://tableausoftware.com>, has a number of training resources. As part of the preparation for the case, you can watch the first few videos at <http://www.tableau.com/learn/training>. (For example, the first lesson in each of the groups of videos Getting Started, Connecting to Data, Visual Analytics, Dashboards and Stories, and Mapping are a good place to start.) These videos demonstrate how to create a time series graph, a geographic visualization, as well as a performance dashboard which will be useful as you complete this project. In our experience, students get used to Tableau's interface quickly and are able to create their own visualizations within 5–10 minutes of seeing the software for the first time.

Perform the following tasks in Tableau:

- Develop a time series plot of number of orders placed for every day in the data set.
- Visualize the aggregate number of orders placed for each day of the month.
- Show a map visualization with all the states in the US and values for the number of orders placed in each state and the average revenue per order in that state.
- Graph the number of site visits per day for all dates in the dataset.
- Graph the number of page views for all dates in the dataset.
- Design a dashboard that simultaneously displays the map visualization and the graph with the number of page views for all dates in the dataset.

## Appendix B. Strategic performance measurement and management during growth

### B.1. Strategy map and balanced scorecard

A strategy map is a helpful visualization tool built around the balanced scorecard concepts that illustrates cause-and-effect relationships between strategic initiatives presented alongside performance measures or key performance indicators (KPIs). A thoughtfully designed balanced scorecard is crucial for performance management and internal decision-making as it enables companies to monitor the strategy execution process. The main attribute of a balanced scorecard is its focus on the few key parameters that are critical to the success of the venture (Kaplan & Norton, 2004). The process of collecting data for KPIs consumes organizational resources and could be costly. For example, Danaher, a DC-based company whose primary business is to acquire and integrate new companies, reduced the number of KPIs from 150 to just 8 in 2006 because of metric and data overload (Roth & Kleiner, 2016).

Typically, a strategy map presents four distinct areas for performance evaluation. They are (Kaplan & Norton, 2004):

- Financial perspective – shows ways to achieve sustainable growth to satisfy shareholders (lag indicators).
- Customer perspective – depicts success with customers and defines customer segments (a combination of lag and lead indicators).
- Internal process perspective – demonstrates how value is delivered to customers (lead indicators).
- Learning and growth perspective – focuses on people, technology, and organizational climate (lead indicators).

### B.2. Properties of metrics

To design KPIs, it is helpful to keep in mind that in order for a metric to be successful, it should be Simple to understand and benchmark against; Map to key business activities, actions to results; Actionable – focus attention and guide right behavior; Reliable and valid; and Timely (SMART). Metrics should also be dynamic where a change in a business process should be reflected in the change in a metric. Also, metrics should not be collected simply because data are available. Instead, metrics should ultimately link to company's success through growth in revenue, profitability, or reduction of risk. Finally, metrics should not be redundant or convey the same information (a correlation analysis could help identify redundant metrics). An example of an incomplete Balanced Scorecard for Bombas, an e-commerce retailer, is presented in Table 1. The focus is on growing revenue from customers in their target markets while ensuring that they acquire new customers and retain existing ones. Also, in order to satisfy their customers, Bombas must have systems in place to make sure that orders arrive on time and that shipping costs are reasonable. Finally, Bombas must focus on fostering a customer-centric culture where

people can create an engaged customer base and sense the pulse for new products that can result in a pipeline of innovative offerings. Please refer to [Table 1](#) for an example of a Balanced Scorecard.

### B.3. Dashboards

While many companies use strategy maps and balanced scorecards as foundational tools for performance management, they often use electronic dashboards to view KPIs. A dashboard effectively depicts indicators using graphics which makes it much easier to tell a story and communicate it throughout the company. It can also be equipped with warning signs or alerts delivered when a metric is outside of preset parameters ([Wolf, 2016](#)).

## Appendix C. Analytics background

“Analytics” is a term most broadly used to describe using computational techniques from fields like statistics, computer science, operations research, and mathematics to extract information from data. The process of extracting information from data typically relies on building *models* but data visualization is a critical component of the process, as has been pointed out also by [Janvrin et al. \(2014\)](#), [Sun, Wu, and Liang \(2013\)](#), and many others). A seminal framework by [Keim, Kohlhammer, Ellis, and Mansmann \(2010\)](#) describes the process of visual analytics as involving multiple iterations of data visualizations and model refinements. Specifically, data from multiple sources may be transformed and formatted for user-specific applications. Ideally, there should be a way for the business user to interact with the data and answer questions of importance to the user through the ability to “drill down” and query the data. This can be accomplished, for example, through interactive data visualization software such as Tableau, IBM Cognos, Qlikview, SAP BusinessObjects Lumira, Oracle Data Visualization Cloud Service, and others. Approaches such as data mining methods may be employed to extract additional information from the data that can inform the business user. Patterns discovered through visualization and predictive models inform further analysis and decision making. The data visualization and the model building therefore work hand in hand to enhance the knowledge and insights extracted from data (see [Fig. 2](#)).

There is an infinite variety of business questions and an infinite variety of visualization and modeling techniques. However, many business questions can be addressed with a small subset of modeling techniques. In fact, the Rexer Analytics Data

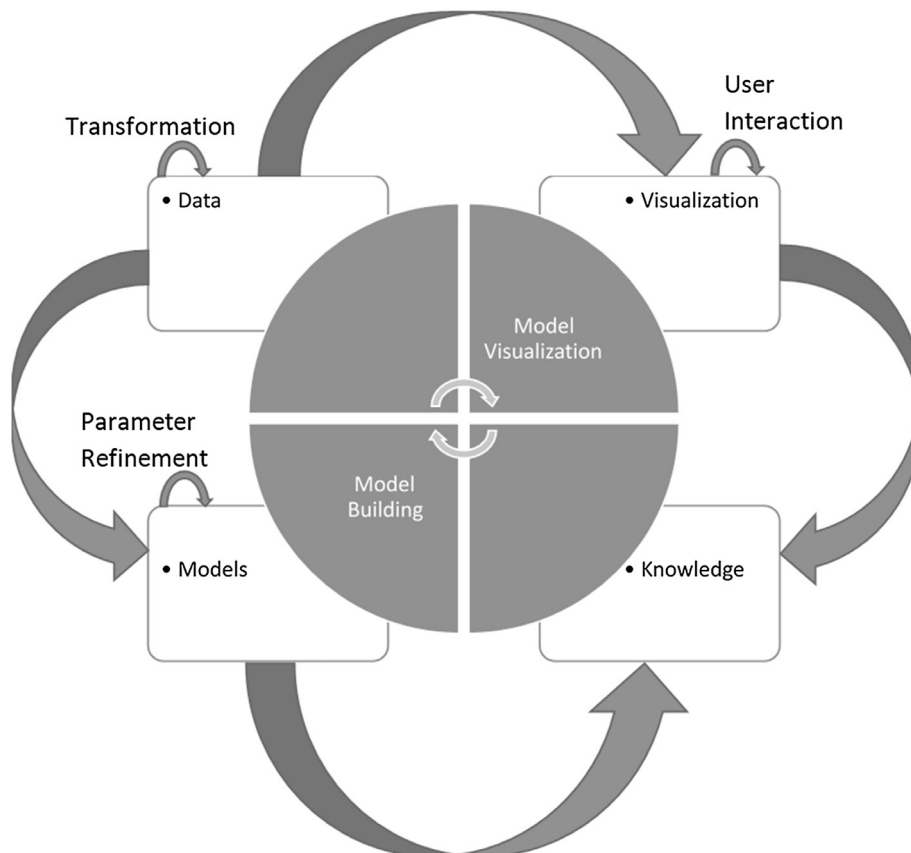


Fig. 2. Overview of the visual analytics process (adapted from [Keim et al. \(2010\)](#)).

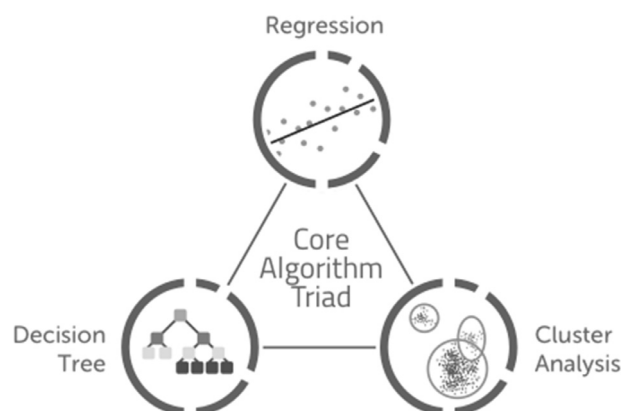


Fig. 3. The three most widely used types of data mining algorithms. Source: [Rexer Analytics data science survey \(2015\)](#). Reprinted with permission.

Science Surveys ([Rexer Analytics, 2015](#)) have shown that three modeling techniques consistently top the list of algorithms used by thousands of modelers around the world since the first survey was conducted in 2007: regression, decision trees, and cluster analysis (see Fig. 3). There are many good references on data mining algorithms for business applications, including [EMC Education Services \(2015\)](#) and [Shmueli, Bruce, and Patel \(2016\)](#).

Regression in its many varieties (linear regression, logistic regression, etc.) has its roots in statistics and is used to create models that predict an output variable of interest based on the values of a set of input variables. The model is an equation that may be used, for example, to predict the lifetime value of a customer (an output variable) based on known customer characteristics (input variables), or the likelihood that a customer will respond to a marketing offer (an output variable) based on past customer behavior.

Decision trees hail from computer science and can be generally applied in many of the same situations as regression techniques. Instead of an equation, they produce a set of rules that allow one to predict an output variable. For example, a rule produced by a decision tree may be that a customer whose age is within a particular range and whose income is larger than a particular threshold is more likely to buy a given product.

Cluster analysis is used to group items or people into groups (clusters) so that items in a cluster are “closer” to each other than to items in other clusters based on a set of characteristics. Cluster analysis is widely used in the context of customer segmentation as well as data preparation for input into various other algorithms.

Analytics techniques are very important in the context of accounting applications ([PwC, 2015](#)): exploratory multivariate statistics, inferential statistics, visualization tools, optimization methods, machine learning, and predictive analysis tools are used in auditing applications; visualization in tax applications; data discovery and visualization techniques in the context of risk management. The ability to identify and frame key business decisions and their related metrics, as well as to communicate recommendations based on complex analytical techniques are also skills highly prized in the market today.

Table 4 summarizes the correspondence of some important business questions and analytical techniques, and explains what the analytical techniques do.

## Appendix D. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jaccedu.2016.12.005>.

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