

Chapter 1 The World of Project Management

This chapter introduces the topic of project management. Projects are defined as temporary endeavors undertaken to create a unique product or service. The chapter points out that recent interest in project management is based on a recognition that many organizational tasks do not fit neatly into business-as-usual. The significant differences between project management and general management are overviewed. The chapter points out that the two primary roles of the project manager are managing trade-offs among the three interrelated project objectives and managing risk. The three interrelated objectives of budget, schedule, and specifications are also introduced. In addition, two alternative project life cycles are presented and the importance of understanding this distinction is discussed. Also included in the chapter is a discussion of project selection including both non-numeric and numeric selection methods. Section 1.3 has been added to introduce Agile Project Management (APM). Included in this section are discussions of why APM was developed, the Agile Manifesto and 12 Agile Principles, and an introduction to scrum. The chapter concludes with a discussion of the aggregate project plan and an overview of the organization of the remainder of the text.

Cases and Readings

Some cases appropriate to the subject of this chapter are:

Harvard: 9-688-040 Boeing 767: From Concept to Production (A); 9-688-041 (B) 9-888-519 Videotape. This 19 page best-selling case shows how a massive corporation manages the evolution of an enormously complex and risky project from conception to manufacture. The 1-page B case is a supplement update about whether Boeing needs to change the way they manage such projects. The video shows the assembly process of an airplane, compressing 10 weeks of work into ten minutes. Good introductory case to the idea of large-scale projects. An 18 page teaching note is available for this case (9-689-027).

Harvard: 9-396-311 BAE Automated System (A): Denver International Airport Baggage-Handling System. This 15-page case describes the difficult, continually-delayed Denver airport project from the viewpoint of one of the contractors. Includes issues of budgeting, scheduling, planning, contracting, and other managerial aspects of this large project. There is also a (B) case, described in Chapter 7: Monitoring and Controlling the Project. A 32 page teaching note is available for this case (5-399-099).

Harvard: 9-692-083 BMW: The 7-Series Project (A); 9-695-013 (B). This 20-page best-selling case describes the situation of a manufacturer with a high-quality product trying to select among two processes for producing its new model. The proposed project for initiating a new production process promises to eliminate start-up production problems and improve quality

but may be less flexible for downstream product improvements. A 13 page teaching note is available for this case (5-692-094). **Harvard: 9-689-073 Plus Development Corp. (B) (Abridged);**

9-693-064 (C). These two cases, normally meant to follow the (A) case (see Chapter 2), describe the need for this corporation to select between alternative methods of product development. The situation is exacerbated by competitors' aggressive actions in the market and mixed results with current development procedures. A 21 page teaching note is available (5-690-093).

Some readings appropriate to the subject of this chapter are:

J.K. Pinto et al. Lessons for an Accidental Profession (*Business Horizons*, March-April 1995).

This reading describes the common occurrence of someone suddenly being appointed a project manager and finding he or she has been inadequately trained for the task. Based on the authors' own experiences and interviews with dozens of senior project managers, they distill twelve guidelines for new project managers. The guidelines run the gamut from project initiation, through planning, to execution, to close-out. Some are technical, some are uncommon sense, and many are philosophical, and sometimes political. But they are sage advice, not only for the novice but for the experienced project manager as well.

1. **Cooke-Davies (2002). The real success factors on projects** (*International Journal of Project Management*, vol. 20, #3, pp 185-190).

This reading uses three questions to question on which factors are critical to project success. The questions are: "What factors lead to project management success?", "What factors lead to a successful project?" and "What factors lead to consistently successful projects?" This paper is based on empirical research from more than 70 large multi-national or national organizations It identifies 12 factors that are, in one way or another, critical to project success.

2. **Thomas, G & Fernández, W. (2008), Success in IT projects: A matter of definition?** (*International Journal of Project Management*, 26, 733-742). This reading investigates how project management success is defined and measured within companies in different industries. The study was done in Australia and provides an international perspective on project success. The authors suggest that when success criteria are formally defined and then measured, IT project outcomes are improved and project resources are better utilized.

Answers to Review Questions

1. What is the primary role of a project manager? How are the primary roles related to one another?

The primary roles of the project manager are managing the tradeoffs among the three project goals (cost, scope, time) and managing risk. The primary roles are related to one another in that to some extent they can be traded-off for one another. For example, managing risk is about managing uncertainty. One uncertainty is whether the project will be completed on time. One way to manage the uncertainty associated with the project being completed on time is to pad the project due date.

2. Contrast a project from a nonproject.

The difference between a project and a nonproject is not always crystal clear. At base, however, projects are unique, have a specific deliverable, and have a specific due date while nonprojects usually do not have all these characteristics.

3. Contrast win-lose negotiation, lose-lose negotiation and win-win negotiation and explain why the latter is so important in project management.

Win-lose negotiation is like a zero-sum game. Anything one side wins is a loss for the other side. In win-win negotiation, the outcome is such that both parties gain something from the interchange.

Win-lose negotiating is dangerous for project managers who will have to deal with the same parties over and over again. The project manager who forces a functional manager to lose will have created a permanent enemy.

4. Identify the three goals of a project. What does it mean for a project to be "overdetermined?"

The three goals of a project are:

1. On time,
2. On budget, and
3. To specification (i.e., including "quality" and "client satisfaction").

An overdetermined project is one that has a fixed budget, fixed delivery time, and fixed specifications (i.e., all three goals are fixed). In reality, projects must have some flexibility to allow for chance events. In the case of an overdetermined project, there is no allowance for any such events.

5. Contrast the two types of project life cycle and discuss why it is important to know which type the current project is following.

The traditional project life cycle (the S-shaped curve) is concave to the baseline during the last stages in the project life (i.e., the curve runs parallel to the x-axis). Some projects, however, have a life cycle curve that is convex to the baseline at the end of the project life (i.e. the curve runs parallel to the y-axis). This is known as a J-shaped curve).

The main reason one should understand the difference is that resource allocation for the two types is quite different. (Cf. Chapters 4 and 6.)

6. How does the weighted scoring approach avoid the drawbacks of the NPV approach? Can the two approaches be combined? How? What weights would be appropriate if they were combined?

The weighted scoring model allows the introduction of nonmonetary and even qualitative elements into the selection criteria. It also allows long-run benefits and risks to be considered.

The two approaches can be combined by including NPV as a criterion in the scoring model. Criteria weights are always selected with the approval of the organization's senior policy makers, but typically the weight on NPV will be quite high if not the highest.

7. Why is it suggested that factors with less than 2 percent or 3 percent impact not be considered in this approach?

Dealing with criteria with such small impact on the final choice uses considerable amount of the decision makers' time and effort and contributes little to the choice.

8. Draw a distinction between a project and a program. Why is the distinction important?

A program is a large generalized effort consisting of a coherent, often integrated set of projects.

The distinction is important because to accomplish a program, it is critical to manage its constituent projects so that they make an optimum contribution to the overall program. This is the basic principal behind the creation of a "project portfolio."

9. Why are R&D projects in a company's Aggregate Project Plan significantly different in type from the firm's Derivative, Breakthrough, and Platform projects?

R&D projects seek to develop new knowledge which hopefully will become the basis for one or more of the other three types of projects: breakthrough, platform, and derivative.

10. Contrast the waterfall approach with Agile in terms of how the work is structured.

In the waterfall approach work is organized into successive phases where the start of one phase is dependent on the completion of the prior phase. In Agile, the work is organized into iterations or sprints of fixed duration. In each sprint specific product functionality goals are set.

11. What are the underlying values associated with Agile?

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

Suggested Answers to Discussion Questions

1. Contrast the three types of nonnumeric project selection methods. Could any specific case combine two of them, such as the sacred cow and the operating necessity, or the comparative benefits and the competitive necessity?

The three types of non-numeric selection models are quite similar in that they have set a single criterion for choice. They differ in that the criteria are different.

An example of using a combination of the sacred cow and the competitive necessity criteria might be a case where a project is set up to find a new and more effective advertising campaign to improve sales for a product suggested by the CEO.

A combination of comparative benefits and the competitive necessity models might be used to choose the appropriate extensions for an application software program that seems too limited in its current level of development to maintain its place in the market.

2. What errors in a firm's project portfolio might the Wheelwright and Clark aggregate project plan graphically identify?

The method will allow senior management to identify the absence or over/under representation of any of the four types of projects; derivative, platform, break through, and R&D. Management can then control the number and direction of each of the types as well as the types as a set or portfolio. The representation might not just be limited to the number of projects but also the resource size of the projects, or their timing.

- 3. You are the project manager of a team of software specialists working on a project to produce a piece of application software in the field of project management. Give some examples of things that might go wrong on such a project and the sorts of trade-offs you might have to make.**

Some of the things that might go wrong would include:

- The project could be delayed ... and the project manager could respond by contracting out, at a higher cost, some of the code writing to shorten the duration of that activity.
- The project could exceed its budget ... and the project manager could respond by negotiating for the removal of some of the less-important program capabilities, that is, reducing the scope.

- 4. In Figure 1- 5, what distribution of large and small circles and squares across the four boxes would characterize a strong, well-positioned product development business? A weak business?**

A well-positioned product development business would generally be characterized by an appropriate mix of R&D, breakthrough, platform, and derivative projects. Generally speaking, a strong product development company will have a mix of all four types of projects with the appropriate mix determined by the organization's overall business strategy. For example:

- Organizations that compete by offering a continuous stream of new products based on the latest technology would likely have a high proportion of breakthrough and R&D projects, some platform projects, and very few, if any, derivative projects.
- On the other hand, an organization that competes in relatively mature markets on the basis of costs may have a lower proportion, or no, R&D projects and a higher proportion of derivative projects.

A weak and poorly-positioned product development business is generally characterized by too large a proportion of simple derivative projects and a mix of projects that are weakly linked to its overall business strategy.

- 5. Give several examples of projects found in your city, region, or country – avoiding those used as examples in the chapter.**

Some projects which might be given as examples include:

1. Construction of a sports stadium.
2. Offering a New Parents Workshop at a church.
3. Building of a large mall or shopping center.
4. Repaving of streets and highways.
5. Organizing the homecoming at a local college.
6. Organizing and conducting a military training exercise.
7. Conducting a census of the population.
8. Organizing and holding a political convention, and,
9. Conducting a bank robbery.

6. For each of the projects identified in the answer to Question 5, is the life cycle for the project S-shaped or J-shaped?

- Construction of a sports stadium – S shaped
- New Parents Workshop – S or J shaped
- Building of a large mall or shopping center – S shaped
- Repaving of streets and highways – S shaped
- Organizing the homecoming at a local college – J shaped
- Organizing and conducting a military training exercise – S or J shaped
- Conducting a census of the population – S shaped
- Organizing and holding a political convention – S or J shaped
- Conducting a bank robbery – J shaped

7. Construct a list of factors, conditions, and circumstances you think might be important for a manufacturing firm to evaluate during the project selection process. Do the same for a computer repair shop.

Manufacturing firm

- *Production factors:* Energy requirements, time required for installation, raw material usage.
- *Marketing factors:* Potential market size, probable market share, time till target market share is acquired, estimated life of product.
- *Financial factors:* Profitability, effect on cash flows, time until breakeven.
- *Personnel factors:* Labor requirements, availability of appropriate labor, impact on working conditions.
- *Other factors:* Impact on environment, meeting government safety standards, patent protections, impact on our image in the industry.

Similar factors could be identified for the computer repair shop as well as others such as:

- *Customer service:* Time to repair, cost to repair, reputation.

8. How might you use project management in doing a major school work assignment?

The strong emphasis on planning and scheduling will increase the likelihood of finishing a term project or paper on time. The planning also improves the chance that the project will be well-structured and have the appropriate content.

9. What advantages are lost if the sum of the weights in a weighted scoring approach does not add to 1.0?

If the weights in a scoring model are normalized to sum to 1.0, each individual weight becomes the percent contribution that criterion makes to the score of whatever is being considered. This makes it simple and quick to see the relative value of that criterion against the others.

10. Why is it important for a project to have “flexibility”?

Flexibility is needed in every project because projects are carried out in an uncertain world which often impedes one or more of the project’s goals. This is why projects should not be “over determined.”

11. What do you see as the major themes in the 12 Agile Principles?

There are certainly alternative ways to categorize the themes in the 12 Agile Principles. One way to categorize them into themes is as follows:

- Customer satisfaction (1-4)
- Quality (1, 3, 4, 6-9, 12)
- Teamwork (4-6, 8, 11, 12)
- Project management (2, 8, 10)

Solutions to Exercises

- 1. A four-year financial project is forecast to have net cash inflows of \$20,000; \$25,000; \$30,000; and \$50,000 in the next four years. It will cost \$75,000 to implement the project, payable at the beginning of the project. If the required rate of return is 0.2, conduct a discounted cash flow calculation to determine the NPV.**

In order to answer this question, the student needs to discount the cash flows in years 1 through 4 (\$20,000, \$25,000, \$30,000 and \$50,000 respectively) to the present using a 30%

discount rate and compare this value with the initial outflow of \$75,000. Using the NPV Excel formula gives the following analysis:

	A	B	C	D	E
1	Req Rate of Return	20.0%			
2					
3	Year	Cash Flow			
4	0	-\$75,000			
5	1	\$20,000			
6	2	\$25,000			
7	3	\$30,000	=B4+NPV(B1,B5:B8)		
8	4	\$50,000			
9	NPV	\$502			

2. A town's council has established a project team to select a project to improve local services for their citizens. Use a weighted scoring model to analyze three possible projects (A, B, C) for improving their services. The relative weights for each criterion are shown in the following table. A score of 1 represents unfavorable, 2 satisfactory, and 3 favorable.

Success Factor	Weight	Project		
		A	B	C
Project cost	20	1	2	3
Timely completion	20	2	3	1
Service quality	10	2	1	3
Contractor relations	10	3	3	2
Affordability	10	2	1	1
Citizen satisfaction	25	1	2	3
County relations	5	2	2	2

This exercise requires that the student set up a matrix as indicated below:

	A	B	C	D	E
1	Success Factor	Weight	A	B	C
2	Project cost	20	1	2	3
3	Timely completion	20	2	3	1
4	Service quality	10	2	1	3
5	Contractor relations	10	3	3	2
6	Affordability	10	2	1	1
7	Citizen satisfaction	25	1	2	3
8	County relations	5	2	2	2
9					
10	Score		165	210	225
11	=SUMPRODUCT(\$B\$2:\$B\$8,C2:C8)				
12					
13	copy to cells D10:E10				
14					

As shown in the spreadsheet above, project C is the best location based on the weighted scores (i.e., it has the highest value).

Note: These weights happen to sum to 100 but this is not necessary. Of course, when the weights are normalized they must sum to 100 except for rounding errors.

3. (a) Compare your answer in Exercise 2 to the answer you would have found if you had used an unweighted, 0-1 scoring model. Assume that a score of 1 means does not qualify and a 2 or 3 means it does qualify.

As shown below, that would result in a score of five for all three projects.

Category	Project		
	A	B	C
Project costs		x	x
Timely completion	x	x	
Service quality	x		x
Contractor relations	x	x	x
Affordability	x		
Citizen satisfaction		x	x
Count relations	x	x	x
Count	5	5	5

- (b) Next, revise the unweighted model by deleting all categories that, as recommended, have a weight of less than 20 percent. Compare to your answer to (a) above and also Exercise 2. Which method seems best?

Deleting all categories that have a weight of less than 20 percent result in selecting B with a count of three, as shown below.

Category	Location		
	A	B	C
Project costs		x	x
Timely completion	x	x	
Citizen satisfaction		x	x
Count	1	3	2

4. Using a spreadsheet for Exercise 2, find the following: (a) What would be your recommendation if the weight for the transportation cost went down to 10 and the weight for union relations went up to 25?

The spreadsheet can be modified by changing the two weightings as follows:

- The entry in cell B5 is changed from 10 to 25, and
- The entry in cell B7 is changed from 25 to 10.

The result of these changes is changes results in project A having a score of 195, project B a score of 225, and project C a score of 210. Project B, therefore, is the preferred project.

(b) Suppose location A received a score of 3 for transport cost and location C received a score of 2 for transport cost. Would your recommendation change under these circumstances?

The spreadsheet can be modified by changing the two evaluations as follows:

- The entry in cell C7 is changed from 1 to 3, and
- The entry in cell E7 is changed from 3 to 2.

Making these changes results in project A having a score of 215, project B a score of 210, and project C a score of 200. Project C is, therefore, the preferred location.

(c) The Mayor has looked at your scoring model and feels that tax considerations should be included in the model with a weight of 15. In addition, the Mayor has scored the locations on tax considerations as follows: A-3, B-2, and C-1. How does this affect your recommendation?

The spreadsheet shown in Exercise 2 can be modified as shown below by adding a new row for tax considerations. According to the results shown below, including tax considerations results in projects B and C both having an identical score of 240.

	A	B	C	D	E
1	Success Factor	Weight	A	B	C
2	Project cost	20	1	2	3
3	Timely completion	20	2	3	1
4	Service quality	10	2	1	3
5	Contractor relations	10	3	3	2
6	Affordability	10	2	1	1
7	Citizen satisfaction	25	1	2	3
8	County relations	5	2	2	2
9	Tax considerations	15	3	2	1
10	Score		0	240	240
11	=SUMPRODUCT(\$B\$2:\$B\$9,C2:C9) copy to cells D10:E10				
12					
13					
14					

- 23. Nina has been asked to lead a team that has been tasked with finding a new location for a boutique concept her company would like to test. The team has identified four candidate shopping centers to locate the new boutique in. Some cater to a higher class of clientele than others, some are in an indoor mall, some have a much greater volume than others, and, of course, rent varies considerably...**

Based on the information provided, Nina believes that Clientele is the most important factor. We therefore somewhat arbitrarily assign this factor a weight of 100. Next, Rent is estimated to be 90% as important as Clientele so it is assigned a weight of 90 ($100 \times .90$). The weights for Indoor mall and Volume are 85.5 ($90 \times .95$) and 72 ($90 \times .80$), respectively, and are calculated in a similar fashion.

According to the results shown in the spreadsheet below, Nina should select Location 1 since it has the highest score.

	A	B	C	D	E	F
1						
2			Location			
3		Weight	1	2	3	4
4	Clientele	100	2	3	1	3
5	Rent	90	3	2	1	3
6	Indoor	85.5	3	1	3	1
7	Volume	72	3	2	3	1
8						
9	Score		942.5	709.5	662.5	727.5
10						
11						
12	=SUMPRODUCT(\$B4:\$B7,C4:C7)					
13	copy to cells D9:F9					
14						

- 6. Using a spreadsheet for Exercise 5, determine how Nina's ability to negotiate a lower rent at location 3, thereby raising its ranking to "good," will affect the overall rankings of the four locations.**

Using the spreadsheet for Exercise 5 and changing cell E5 from 1 to 3 increases the score of Location 3 from 662.5 to 842.5 and thus from having the lowest score to the second highest score.

Note: since the scores for the other three locations are not impacted by this change, the overall recommendation (location 1) remains unchanged.

Incidents for Discussion Suggested Answers

Broken Welds

Question: What information does Alison need to determine the probable impact of Kelsey's proposed project on the other projects in the department?

Alison needs the following information to estimate the cost/benefits of starting Kelsey's project, namely:

- o An estimate of the rework charges for failed welds and the estimated number of welds that will have to be redone. Kelsey's project may stop these costs.*
- o A rough estimate of the time and resources required to carry out Kelsey's proposed project.*
- o The impact the immediate use of these resources will have on the department's other projects over the estimated life of Kelsey's project.*

Question: Should her findings affect her decision about Kelsey's project? How?

For any current projects delayed, the projects' benefits may be delayed and this is also a cost assignable to Kelsey's project. These costs and benefits should immediately be shown to the Chief Engineer before proceeding with Kelsey's project though Kelsey may do some informal initial planning.

Suggested Case Analyses and Solutions

Friendly Assisted Living Facility – 1

Teaching Purpose: The Friendly Assisted Living Facility cases comprise a set of cases beginning in this chapter and are all associated with the same project – the planning, building, and marketing of an assisted living facility for people whose state of health makes it difficult for them to live independently, but who are not yet ill enough to require nursing home care. In this initial installment of the case, students address issues related to the project deliverables, project constraints and assumptions, the development of an action plan, and the selection of a project manager.

1. Identify as well as you can the three iron triangle constraints for this project: cost, time, and scope.

Cost: \$11 million;

Time: start after Nov 20X6, finish by July 20X7;

Scope: construct a project plan, purchase land, purchase furnishings, purchase materials and contract labor to construct building and connection, and train staff in the new facility services.

2. Identify the expected benefits of this project for Friendly Medical Center.

- A profit program for the Center but under their control that would gain net cash flow of \$1.5 million/year;
- Improve the local image of Friendly Medical Center;
- Gain additional referrals to the Center's outpatient therapy programs;
- Increase the census in the hospital's inpatient units, and
- Provide better care for the community in terms of reimbursable preventive and wellness programs.

3. Comment on the strategic initiatives resulting from the Board's major strategic planning retreat. Would you consider this a productive retreat?

The outcomes of the retreat were rather shallow. Better would have been to have come up with these two initiatives at a special board meeting and then collect data to decide at the retreat what areas to focus on for improving the cost effectiveness of patient care delivery and what alternatives to explore in more detail for new programs and services that would capitalize on their excellent staff and reputation.

**4. What “project selection” procedure was used here? How common do you think this is?
How wise do you think it is?**

This was basically a “sacred cow” approach by the CEO, probably not that uncommon. Although the idea sounds like it could be a success, we don’t see any risk analysis being considered, or the consideration of other alternatives that might have been even more promising.

Handstar Inc.

Teaching Purpose: This case requires students to rank a number of candidate projects using both the NPV approach and the weighted scoring model approach. The case demonstrates how the NPV approach can be combined with the weighted scoring approach in evaluating projects.

Question 1: Which projects would you recommend Handstar pursue based on the NPV approach?

The spreadsheet bellow summarizes the NPV calculations for the six projects assuming the development costs are incurred at the end of year zero and each product has a three year life. Since the six projects require a total of 13,025 development hours and only 10,000 hours are available, one or more projects will need to be postponed or eliminated from further consideration.

If we start with the project with the highest NPV, the Browser project would be selected first requiring 1,875 hours of development time. Next, the Trip Planner would be selected requiring an additional 6,250 hours of development time. The project with the next highest NPV is the Spreadsheet project. However, this project requires 2,500 hours and only 1,875 hours are available after selecting the Browser and Trip Planner projects. The project with the next highest NPV is the Calendar/Email project which requires 1,250 hours of development time leaving 625 hours available. Of the remaining projects, the Portfolio Tracker requires too many hours while the Expense Report project can be completed with the hours available. Thus, Browser, Trip Planner, Calendar/Email, and the Expense Report projects would be selected based on the NPV approach.

For students that have been exposed to optimization and Solver, a better approach for solving this problem is to set it up as an optimization model where the objective function is to maximize the total NPV subject to the available hours.

Discount rate	12%						
Hourly Rate	\$52.00		130000				
	Calendar/	Expense	Portfolio			Trip	
	Emai	Report	Tracker	Spreadsheet	Browser	Planner	
Growth rate	-10%	5%	5%	10%	15%	5%	
Development time	1250	400	750	2500	1875	6250	hours
Development cost	\$65,000	\$20,800	\$39,000	\$130,000	\$97,500	\$325,000	
Year 0 Cash Flows	(\$65,000)	(\$20,800)	(\$39,000)	(\$130,000)	(\$97,500)	(\$325,000)	
Year 1 Cash Flows	\$750,000	\$250,000	\$500,000	\$1,000,000	\$2,500,000	\$1,300,000	
Year 2 Cash Flows	\$675,000	\$262,500	\$525,000	\$1,100,000	\$2,875,000	\$1,365,000	
Year 3 Cash Flows	\$607,500	\$275,625	\$551,250	\$1,210,000	\$3,306,250	\$1,433,250	
NPV	\$1,575,155	\$607,862	\$1,218,324	\$2,501,025	\$6,779,899	\$2,944,043	

Question 2: Assume the founders weigh a project's NPV twice as much as both obtaining/retaining a leadership position and use of the Internet. Use the weighted factor scoring method to rank these projects. Which projects would you recommend Handstar pursue?

Data is available for the six projects on these three criteria. Based on the information given in the question, we will assign a weight of 0.5 to NPV and 0.25 to both obtaining/retaining a leadership position and use of the Internet. In terms of scoring the options on NPV, a score of 1 was assigned to the projects with NPVs less-than-or-equal-to 1.1 million dollars. Likewise, a score of 2 was assigned to projects with NPVs that were greater than 1.1 million dollars but less-than-or-equal-to 2.5 million dollars. Projects with NPVs greater than 2.5 million dollars were assigned a score of 3. For the other two criteria, projects with low probabilities were assigned a score of 1, moderate probabilities a score of 2, and high probabilities a score of 3. A spreadsheet for calculating the weighted scores is shown below.

The only difference with the weighted scoring model is that the Calendar/Email project moves ahead of the Spreadsheet project. However, the same set of projects will be selected.

	A	B	C	D	E
1		NPV	Leadership	Internet	Score
2	Weight	0.5	0.25	0.25	
3					
4	Calendar/Email	2	2	2	2
5	Expense Report	1	3	1	1.5
6	Portfolio Tracker	1	3	2	1.75
7	Spreadsheet	2	2	1	1.75
8	Browser	3	1	3	2.5
9	Trip Planner	3	1	3	2.5

Question 3: In your opinion, is hiring an additional software development engineer justified?

After selecting the Browser, Trip Planner, Calendar/Email, and the Expense Report projects, a total of 225 hours would be available. Hiring an additional software engineer would increase the number of available hours to 2,725. Since the Spreadsheet project has a higher NPV and higher score than the Expense report project it would be the next project to select. Given that its NPV of \$2,233,058 greatly exceeds the \$133,000 ($\$52/\text{hour} \times 2500 \text{ hours/year}$) incremental cost of the new software development engineer, hiring an additional software engineer is justified. Indeed, the Expense Report's NPV in excess of \$500,000 would appear to justify hiring a second software development engineer as well.