

## ***Project Business Management*** <sup>1,2</sup>

# **Bottlenecks and Other Opportunities**

**Oliver F. Lehmann, MSc, ACE, PMP**

*“I have learnt that all our theories are not Truth itself,  
but resting places or stages on the way to the conquest of Truth.”*

- Justus von Liebig



## **Summary**

The article underscores the importance of recognizing and addressing bottlenecks in customer projects to enhance performance, profitability, and resource allocation. It delves into the application of Liebig's Law of the Minimum to project management and emphasizes how a project's success is tied to its scarcest resource. Furthermore, it showcases a company grappling with challenges stemming from resource constraints and offers practical solutions to elevate project management and drive better business outcomes.

<sup>1</sup>This is an article in a series by Oliver Lehmann, author of the book “[Project Business Management](#)” (ISBN 9781138197503), published by Auerbach / Taylor & Francis. See full author profile at the end of this article. A list of the other articles in PM World Journal can be found at <https://pmworldlibrary.net/authors/oliver-f-lehmann>.

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## The Chemist Who Changed the World

The story of Justus von Liebig is one of relentless curiosity, bold experimentation, and a deep desire to understand and improve the world around him. Born in 1803 in Germany, Liebig was destined for a life far removed from the ordinary. His journey from a young alchemist in his family's kitchen to a revered scientist, educator, and leader would change the face of chemistry, agriculture, and the very way we think about scientific inquiry.

### The Young Alchemist and the Seeds of Revolution

From a young age, Liebig was enchanted by the mysteries of chemistry. His parents' kitchen was often filled with the smell of burning sulfur and the sight of bubbling beakers as he experimented with anything he could get his hands on. Over time, his early fascination with the alchemists' tales of turning lead into gold evolved into a more serious pursuit of understanding the elements that make up our world. When he was just a teenager, it became clear that Liebig's future lay not in traditional trades, but in the frontiers of science.

After a brief stint in Paris, where he was exposed to the latest chemical theories, Liebig returned to Germany and, at the remarkable age of 21, became a professor at the University of Giessen in 1824. It was here that his real work began—not just in the lab, but also in the classroom. Dissatisfied with the theoretical nature of chemistry education, Liebig established the world's first laboratory dedicated to teaching chemistry hands on. The Giessen Laboratory quickly became a beacon for young scientists eager to learn through experimentation rather than mere memorization.

### Discovering the Law of the Minimum: A Radical Idea Takes Root

Liebig's early years at Giessen were marked by a bold questioning of agricultural practices. Farmers for centuries had relied on animal manure to fertilize their fields, yet few understood why it worked. The prevailing belief was that soil contained a "vital force" that plants absorbed. Liebig, however, wasn't satisfied with this mystical explanation. He believed that plant growth was a chemical process and set out to prove it.

His laboratory became a living garden of sorts—pots of plants, tubes of soil samples, and an array of strange devices for measuring and analyzing. Liebig and his students conducted painstaking experiments, burning plant samples, analyzing ash content, and testing soils with various nutrients. After years of careful study, he noticed a pattern: plants needed a specific combination of nutrients to thrive, and it wasn't the presence of nutrients in general that mattered, but the presence of the limiting nutrient—the one in the shortest supply. This became known as Liebig's Law of the Minimum.



Figure 1: Liebig's barrel

To explain this idea, Liebig often used the analogy of a barrel with staves of different lengths. The capacity of the barrel—just like the growth potential of a plant—was determined not by the longest stave, but by the shortest one. If even one essential nutrient was missing or insufficient, the plant's growth would be stunted, no matter how abundant the other nutrients were. This was a revolutionary concept that challenged the deeply held beliefs of his time.

### The Professor Who Transformed Science: From Giessen to Munich

While Liebig's Law of the Minimum shook the agricultural world, his influence went far beyond his discoveries. As a professor at Giessen, Liebig transformed the very nature of scientific education. His laboratory became the model for chemistry education worldwide, emphasizing hands-on experimentation and research. His students became some of the most prominent chemists of their era, spreading his methods and ideas across Europe.

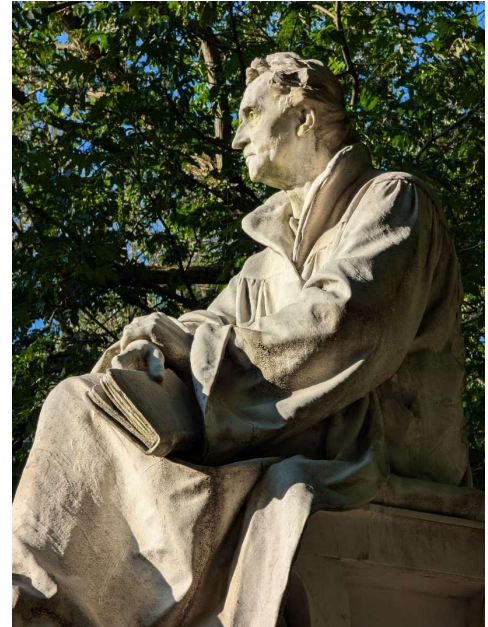
By the early 1850s, Liebig's reputation had grown beyond Germany. His work in organic chemistry and agricultural science had made him a giant in his field, and he was invited to take a prestigious position as a professor at Ludwig Maximilian University (LMU) in Munich. Here, Liebig continued his pioneering work, but he also took on a more significant role as a mentor and leader in the scientific community.

In Munich, Liebig's lectures were packed, his laboratory bustling with young minds eager to learn. He expanded his research into areas such as animal physiology and the chemistry of metabolism, proving that his intellectual curiosity knew no bounds. It was during this time that his role evolved from a scientist making discoveries in the lab to a statesman of science—someone who understood that the power of knowledge could only be fully realized if shared, taught, and applied.

## Leading the Scientific Community: President of the Royal Bavarian Academy of Sciences

In 1858, Liebig's influence in science reached a new height when he was elected as the president of the Royal Bavarian Academy of Sciences. In this role, he was more than a figurehead; he became a powerful advocate for science as a force for societal progress. Liebig saw the future of science as interdisciplinary and pushed for collaboration among chemistry, biology, and physics. Under his leadership, the Academy became a hub for scientific innovation and a platform for challenging outdated ideas.

Liebig's presidency was marked by his commitment to evidence-based science. He railed against pseudoscience and was a vocal critic of quacks who sold miracle cures and fertilizers with no scientific basis. His rigorous standards and insistence on scientific integrity earned him both admiration and enmity. He championed government support for scientific research and education, arguing that the prosperity of nations depended on their scientific prowess. His vision helped Bavaria emerge as a leader in scientific and technological development.



*Figure 2: Justus v. Liebig, statue in Munich, sponsored by his students*

## Liebig's Law in Project Management

Expanding Liebig's Law of the Minimum into project management offers a compelling way to understand how limitations in resources, skills, or processes can constrain a project's success. In this context, Liebig's Law of the Minimum can be adapted to illustrate how the "growth" or "success" of a project is determined by its scarcest or weakest resource. This principle can guide project managers in identifying and addressing bottlenecks that limit progress.

### The Concept

Just as **Liebig's Law of the Minimum** states that plant growth is limited by the scarcest nutrient (the shortest stave in a barrel), project success can be seen as limited by its weakest element—whether that be a lack of skills, resources, time, or communication. This expanded view suggests that even if a project has an abundance of certain resources (like funding or manpower), the project's overall success will still be constrained by its most deficient aspect.

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## Key Elements of Liebig's Law Applied to Project Management

1. **Resource constraints:** Projects require a variety of resources, such as time, budget, personnel, technology, and information, and also the most critical of all: Management attention. According to Liebig's Law, the most limiting factor among these will define the project's success or failure. For instance, if a project is well-funded and has skilled personnel but lacks time, the lack of time will limit the project's ability to succeed.
2. **Skill deficiencies:** Even in a well-resourced project, lacking specific skills or expertise can be a critical limiting factor. For example, in a software development project, having plenty of developers but lacking skilled UI/UX designers could bottleneck the entire project's completion.
3. **Process inefficiencies:** Inefficient processes or systems can act as a limiting factor. Suppose a team has the right skills, resources, and time, but the decision-making process is slow or poorly defined. In that case, the project will only move as fast as this bottleneck allows.
4. **Communication and collaboration gaps:** Poor communication can be the weakest link in any project. If team members, supervising stakeholders, or contributing departments are not aligned or misunderstand project goals, objectives, timelines, or responsibilities, this can severely limit progress, regardless of other resource abundance.
5. **External Factors:** Sometimes, the limiting factor might be external—such as regulatory constraints, market conditions, or dependency on contractors. These elements can limit the project's growth and success if they are not effectively managed or mitigated.
6. **The dynamic nature of bottlenecks:** When one bottleneck has been widened, another one will occur. For example, when manpower was a problem but has been resolved by adding more people to the team, another resource may become the bottleneck such as space that allows all to do their work or management attention, that must be given to many more people.

## Practical Applications of Liebig's Law in Project Management

1. **Bottleneck identification and management:** Project managers can use this principle to identify the weakest link or bottleneck in their project. Tools like SWOT analysis, critical path analysis, and bottleneck analysis can help pinpoint these constraints. By focusing on improving the weakest area, project managers can increase the overall potential of the project.
2. **Prioritization of efforts:** Applying Liebig's Law can help in prioritizing efforts and resources. Instead of distributing resources evenly across all areas, project managers can allocate more to address the weakest points, thereby optimizing the project's growth potential.



3. **Risk management:** By understanding that a single limiting factor can halt progress, project managers can proactively identify and mitigate risks. Regular assessments can help anticipate what might become a limiting factor and allow for contingency planning.
4. **Iterative improvement:** Just as in agriculture where adjusting the deficient nutrient can lead to better crop yields, in project management, continuously addressing and improving the most limiting factors can lead to incremental project success. This is similar to Agile and Lean methodologies, where constant iteration and refinement are key.
5. **Balanced scorecard approach:** Using a balanced scorecard approach in project management can be a practical application of Liebig's Law. By evaluating multiple dimensions (financial, customer, internal processes, learning, and growth), project managers can identify which dimension is limiting overall performance and focus on improving it.

## Liebig's Law in Project Business Management

### Case Story: A Tale of Two Eras

Once upon a time, in a bustling corner of the corporate world, there existed a company named Strongarm HiTec Services, Inc. (SHS)<sup>3</sup>. Focused on customer projects, it was the envy of all. A startup, brimming with youthful energy and boundless ambition, it had rapidly ascended to the pinnacle of profitability. Its projects were a symphony of efficiency, its employees a chorus of joy.

But as time marched on, a subtle shift began to take place. The once-vibrant company SHS began to feel a pang of weariness. Its profits, once as abundant as summer rainfall, started to dwindle. The once-gleaming returns on assets began to tarnish. The joy that had once fueled its projects seemed to fade into a distant memory. Instead, the corporate staff acted complacently and often understood their work as "Business as usual", not as challenging and thrilling Project Business. And it was not a lack of customers that caused the problems. Just the opposite—SHS typically did 50 or more projects concurrently with a staff that would have elsewhere just worked on 40 projects.

What had happened? Why had this once-thriving enterprise lost its luster? The answer lay in the invisible forces that shape a company's success: its resources.

Like a delicate ecosystem, a company's growth is limited by the availability of its most scarce resources. In this case, these scarcest resources were Management Attention and people. It seemed that the company had reached a critical juncture. These resources, once plentiful,

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<sup>3</sup> The story is based on a real case, but the name is changed.

were now stretched thin. Too many projects required the attention of the company's upper management, and good people were scarce.

Perhaps it had outgrown its capital, unable to secure the necessary funding for expansion or innovation. Perhaps its talent pool had dried up, struggling to attract and retain top-tier employees. Perhaps the market had become saturated, leaving little room for growth and differentiation. Or perhaps the company's culture had grown stale, stifling creativity and innovation.

To reclaim its former glory, the company needed to identify the limiting resource and take decisive action. It was like a gardener tending to a wilting plant: to revive it, one must find the root of its ailment and provide the necessary nourishment.

The company tried to find external help and soon found it in an assessor, who spoke with staff and observed their working. Soon, he submitted his report. Here is what he found:

## Understanding the Dilemma

The greater the company grew, the higher the number of concurrent projects was. In the following thought lines, I describe the mechanism with just three projects, however at SHS, there were around 50 projects involved. But indeed, the underlying dynamics remained the same, they were just harder to make out.

Picture a company that has a portfolio of three concurrent customer projects, named Project A, Project B, and Project C. Each project is done for a different customer. Figure 3 shows that Project B is the largest project in matters of work and cost levels currently consumed, Project C the smallest.

All three projects run against tight deadlines.<sup>4</sup>

It can also be seen that Project A is late, while the other two projects are on schedule. To make things more difficult, the deadline for Project A is the nearest and most pressing. Coming late is commonly connected with disadvantages for the contractor, such as penalties<sup>5</sup>, liquidated damages<sup>6</sup>, or unpaid incentives. It may also destroy the contractors reputation as reliable and dependable.

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<sup>4</sup> Market research shows that roughly  $\frac{3}{4}$  of all projects are performed against deadlines (Lehmann, 2017).

<sup>5</sup> Typical for Civil Law systems

<sup>6</sup> Typical for Common Law systems

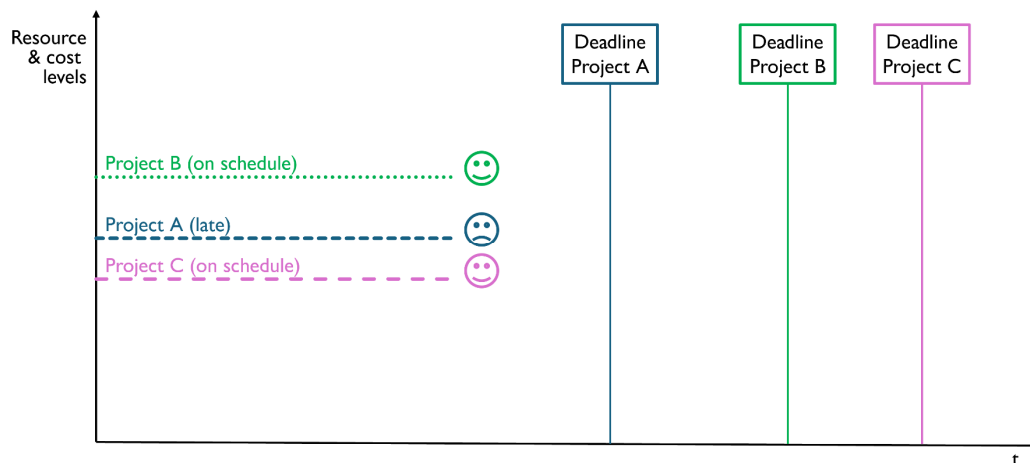


Figure 3: The portfolio with 3 customer projects. Project A is late.

The attention is now on Project A. What can the organization do to help Project A deliver on time? A common response is called “crashing”<sup>7</sup>, adding resources such as people, equipment, and others to accelerate the project. Crashing also comes with additional costs, but in the example, they help meet the deadline, as seen in Figure 4.

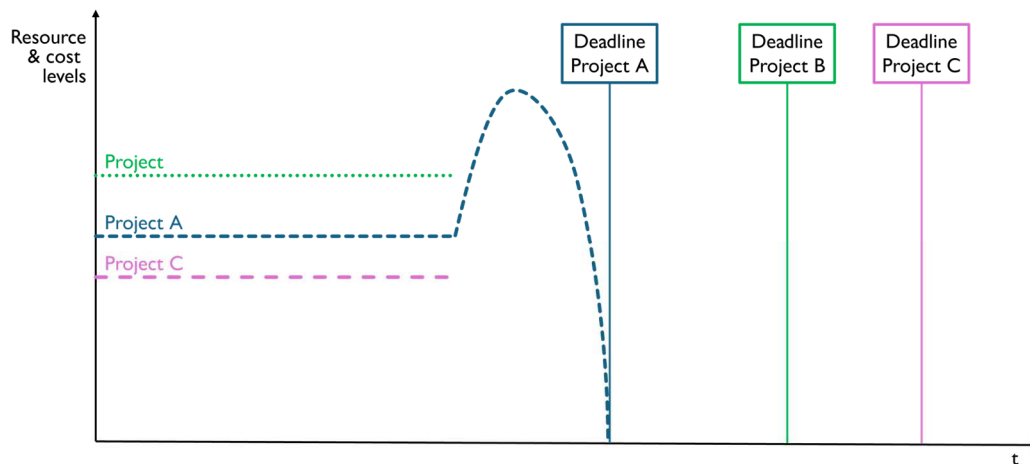
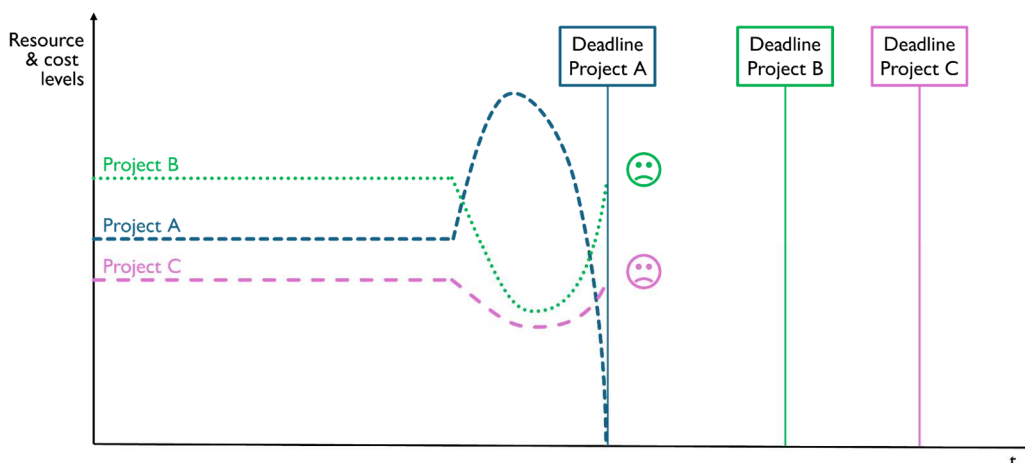


Figure 4: “Crashing” helps Project A meet its deadline.

Where are these additional resources taken from? As resources are commonly limited inside the organization, and there is rarely enough time to find free resources externally and buy them from subcontractors, they are often taken from other projects. Figure 5 shows the effects on these projects.

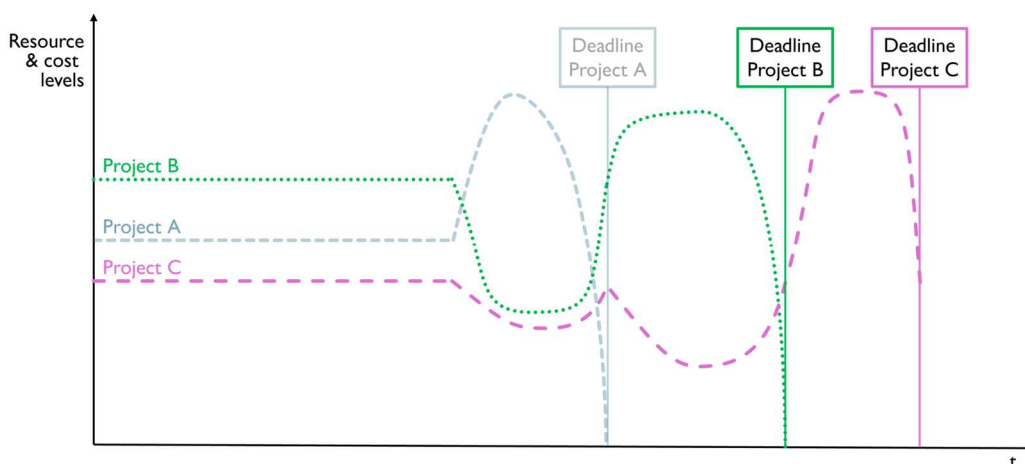
<sup>7</sup> (PMI, 2021, p. 238)





*Figure 5: Having to temporarily give resources away to Project A, Project B and to a lesser degree also Project C run also in a situation of delay.*

Now, Project B requires special attention. It receives the resources that Project C would need to get back on track and some more to finish on time. Once it is finished. All resources are thrown into Project C to also finish on time, as shown in Figure 6.



*Figure 6: Like a line of dominoes, crashing goes on from Project to project.*

One may say, but now, that this crisis is over the company can get back to normal, however, there are typically more project started, which run into the same trap. And remember that SHS has 50 projects performed concurrently. When one project was crashed out of crisis, a chorus of other project screamed for help.

For a company doing customer projects, the scenario described is highly detrimental. It has a number of negative effects:

## What the Dilemma Means for Project Business

If a company continuously applies “crashing” to its projects—where “crashing” refers to the process of accelerating project timelines by adding resources or working overtime to

increase the speed of completion—several consequences can impact profitability, cash flow, and staff well-being:

## 1. Profitability Consequences

- **Increased Costs:** Crashing projects often involves adding more resources (e.g., hiring additional staff, paying for overtime, or expediting materials). These additional costs can significantly erode the profit margins of projects. Even if projects are completed faster, the increased expenses may offset any gains from early completion.
- **Diminishing Returns:** The more a project is crashed, the less efficient the process becomes. Initial crashing may yield high productivity gains, but subsequent efforts often lead to diminishing returns where the cost of speeding up becomes higher than the benefits gained, negatively impacting efficiency and profitability.
- **Higher Risk of Errors and Rework:** Accelerating timelines can lead to quality issues and errors due to reduced time for quality assurance and rushed work. The cost of rework and fixing errors can further reduce profitability, especially in industries where defects have substantial cost implications (e.g., software development, construction).

## 2. Cash Flow Consequences

- **Outlays:** In the short term, crashing customer projects stretches the credit line. The costs of additional resources must be paid immediately, while the payment cycles with the customers remain unchanged.
- **Increased Outflows Due to Overtime and Premium Rates:** Cash outflows can spike due to increased overtime pay, expedited shipping costs, and other rush expenses. These costs can strain the company's working capital, leading to potential cash flow challenges.
- **Potential for Delayed Cash Receipts Due to Poor Quality:** If crashing leads to lower quality outputs, customers may withhold payment until corrections are made or may negotiate reduced payments, causing delays in cash inflow and increasing accounts receivable turnover times.

## 3. Staff Burnout Consequences

- **Employee Burnout and Turnover:** Constantly crashing projects can lead to increased stress, long hours, and a demanding work environment. This will result in burnout, decreased job satisfaction, and high employee turnover rates. Replacing and training new employees can be costly, further affecting profitability.
- **Decreased Productivity Over Time:** Prolonged periods of overwork can lead to decreased productivity, as fatigued employees make more mistakes and take longer to complete tasks. Over time, this decreases the overall efficiency of the workforce.

- **Impact on Morale and Company Culture:** A culture of constant rushing can erode employee morale, making it difficult to retain talent and negatively impacting the company's reputation as a desirable workplace. This can lead to challenges in attracting skilled employees, further increasing hiring costs.

While crashing projects can offer short-term benefits such as quicker cash inflows or meeting tight deadlines, continuously applying this approach can have significant negative consequences on profitability due to increased costs and inefficiencies. The resulting strain on cash flow and the negative impact on employee well-being can create a cycle of declining productivity, quality issues, and financial stress. Therefore, companies should use crashing judiciously, balancing the need for speed with cost management, quality assurance, and maintaining a healthy work environment for employees.

## The Solution

In the case story with SHS, the consultant recommended reducing the number of projects performed to a level that would be sustainable with the staff at hand—internal and from subcontractors—to keep up motivation, team spirit, and profitability.

A second recommendation was to be pickier about the project enquiries that the company responds to by sending offers. So far, SHS tried to win every bid or proposal, bringing more business home than what it could process. When the amount of work gets limited, the company can focus more on winning the good and profitable projects and leaving the rest to competitors, keeping them busy with poor business.

A third recommendation was to put more emphasis on the company's people. SHS's focus so far was always on technology, mostly ignoring what drives their people to bring in their motivation, inspiration, and problem-solving skills. It was important to reignite the fire that once burned in the company's staff to bring it up to the performance that it is capable of.

## Conclusion

The problems at the identified bottleneck of SHS finally turned out as an opportunity to finally make decisions that the rapid growth of the company would have made necessary long ago, but that were never made due to the high stress that over time turned from positive eustress more and more into damaging distress.

Following the consultant helped navigate the company to calmer waters, bringing back the joy of doing good work, and finally improved the company's business. In the end, this was also noticed by customers that it was more joyful to work with the company again.

## Appendix: What is Project Business?

Project Business takes place when two or more organizations do a project together as customers and contractors. In Project Business, the project is no longer solely there to support a business. It is the business. It is the business.

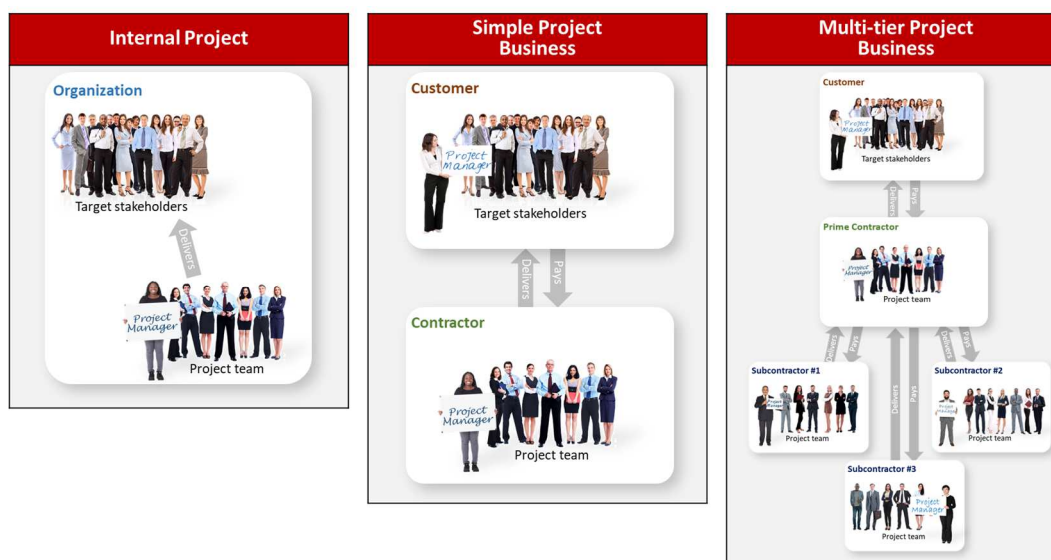


Figure 7: In contrast to internal projects, where the target stakeholders of the project and its performing team are located in the same organization, Project Business is cross-corporate with two or more—often many more—organizations involved.

Project Business is different from internal, cross-functional projects. In a simple scenario, just two organizations may be involved: A customer and a contractor. In mega-projects, such as major infrastructure, aerospace and defense programs, or even Olympic games, hundreds of organizations may work together towards a common goal. Typically, these organizations build complex and dynamic multi-tier project supply networks. For most of them, the project is not a cost center but a customer project—a profit center. It must bring money home and safeguard the organization's credit line.

Many companies rely on project business as their sole source of income. As contractors, they sell project services and products against payment. Others include customer projects as a component in their proposition packages: They sell hardware, software, or ongoing services, and the project to implement these on the customer side is part of their success formula for the paying customer.

The high art of Project Business is forging the different organizations together and making them follow a common mission: The successful completion of the project. Ideally, contract parties become project partners teaming up for the benefit of each of them and for the smile on everyone's face when they have achieved a desired and distinguished result together, a result that one organization alone could not have achieved.

Project Business is not a fringe topic of project management—it's a big, global trend across all industries.

## References

Lehmann, O.F. (2017) 'Resolving Crises in Customer Project with Benefits Engineering', VI (X), October [Online]. Available from: <https://pmworldlibrary.net/wp-content/uploads/2017/10/pmwj63-Oct2017-Lehmann-resolving-crises-in-customer-project-with-benefits-engineering2.pdf> (Accessed: 28 August 2024).

PMI (2021) *A Guide to the Project Management Body of Knowledge - PMBOK Guide*, 7<sup>th</sup> edition, Newtown Square, PA, USA: PMI - Project Management Institute, Inc.

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## About the Author

Oliver F. Lehmann  
Munich, Germany



Oliver F. Lehmann, MSc, ACE, PMP, is a project management educator, author, consultant, and speaker. In addition, he is the owner of the website [Project Business Foundation](http://Project Business Foundation), a non-profit think tank for professionals and organizations involved in cross-corporate project business.



He studied Linguistics, Literature, and History at the University of Stuttgart and Project Management at the University of Liverpool, UK, where he holds a Master of Science Degree (with Merit). Oliver has trained thousands of project managers in Europe, the USA, and Asia in methodological project management, focusing on certification preparation. In addition, he is a visiting lecturer at the Technical University of Munich.

He has been a member and volunteer at PMI, the Project Management Institute, since 1998 and served as the President of the PMI Southern Germany Chapter from 2013 to 2018. Between 2004 and 2006, he contributed to PMI's *PM Network* magazine, for which he provided a monthly editorial on page 1 called "Launch," analyzing troubled projects around the world.

Oliver believes in three driving forces for personal improvement in project management: formal learning, experience, and observations. He resides in Munich, Bavaria, Germany, and can be contacted at [oliver@oliverlehmann.com](mailto:oliver@oliverlehmann.com).

Oliver Lehmann is the author of the books:

- [“Situational Project Management: The Dynamics of Success and Failure”](#) (ISBN 9781498722612), published by Auerbach / Taylor & Francis in 2016
- [“Project Business Management”](#) (ISBN 9781138197503), published by Auerbach / Taylor & Francis in 2018.

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