JOURNAL OF BUSINESS CHEMISTRY

The academic journal for management issues in the chemical industry

Volume 20

Issue 3

Universität Münster

provadis Hochschule

ISSN 1613-9623

Vol.20, Iss.3, October 2023

Aim and Scope

The Journal of Business Chemistry (JoBC) focuses on current developments and insights at the intersection of management and chemistry, biotechnology or pharmacy.

The JoBC provides an international forum for researchers and practitioners in companies, research institutes, public authorities, consultancies or NGOs to present and discuss current challenges as well as potential solutions in an interdisciplinary manner. Thus, the JoBC aims to foster the dialog between science and business, to support management practice in the chemical and pharmaceutical industry and to indicate where further research from academia is needed. The JoBC offers high quality publications with academic standards, a fast publishing process and global reach. With this multidisciplinary and boundary-spanning approach, the JoBC intends to become the leading journal for decision makers in the chemical and pharmaceutical industry.

Publisher

The Journal of Business Chemistry (Online ISSN 1613-9623) is jointly published by Prof. Dr. Jens Leker (affiliated with the Institute of Business Adminstration, University of Münster) and Prof. Dr. Hannes Utikal (affiliated with the Center for Industry and Suistainability, Provadis School of International Management and Technology). It is published every four months as an open access journal.

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- EBSCO Publishing
- Hamburg Institute of International Economics
- German National Library of Economics
- Chemical Business NewsBase (CBNB) by Elsevier Engineering Information, Inc.

JOURNAL OF
BUSINESS CHEMISTRY

Vol.20, Iss.3, October 2023

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ISSN 1613-9623

Letter from the Editors

Endings and new beginnings

After a bit more than three years, it is time for us to say goodbye as Executive Editors of the Journal of Business Chemistry. We look back on many successful issues and are very grateful for the support of all authors and reviewers for this and previous issues. We would now like to hand over to Andrea Kanzler who will be Executive Editor beginning from the next issue, and we could not be more confident that the Journal of Business Chemistry will continue to flourish.

The first article "Building bridges in education: Exploring how engineering and MBA students can work together to help the environment using biodiesel" by Yassir Samra, James Patrick Abulencia, Emilia Golebiowska Purington, and Giovanni Kelly, is an example of interdisciplinary collaboration between chemical engineering and business students at Manhatten College. The article describes how the students learned about interdisciplinary teamwork and sustainable innovation by converting waste vegetable oil into biodiesel and conducting a feasibility analysis.

In his commentary "Intercultural leadership – A need for now and the future in chemical industry. A personal observation based on experience.", Bernd Scharbert shares his experiences as an international manager of a large chemical company. He begins by taking the reader through various stages of his career and emphasizes that intercultural leadership skills are crucial for efficient and harmonious global teams. He then describes global leadership challenges and outlines key lessons learned. Finally, he summarizes three success factors for improving the performance of a global team: Cultural Wisdom, Ambiguity Tolerance, and Language Sensitivity.

In their book review, Stephan Haubold and Mathias Seifert take a closer look at „Chemistry Entrepreneurship" by Javier García-Martínez and Kunhao Li published in 2022. Chapter by chapter, they give an overview of the content, and it quickly becomes clear that this is less an academic textbook than a practical guide. Furthermore, it becomes clear that the concept of chemical entrepreneurship is defined in a rather broad manner and includes neighboring natural science. A clear strength of the book are the numerous case studies, which encourage and inspire the reader. Overall, the authors recommend the book, for natural scientists, engineers, and early technology entrepreneurs in general.

Please enjoy reading the third issue of the twentieth volume of the Journal of Business Chemistry. If you have any comments or suggestions, please do not hesitate to contact us at contact@businesschemistry.org. For more updates and insights on management issues in the chemical industry, follow us on LinkedIn: www.linkedin.com/company/jobc/ and subscribe to our newsletter.

Janine Heck (Executive Editor)	Bernd Winters (Executive Editor)

JOURNAL OF
BUSINESS CHEMISTRY

Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518704
DOI: 10.17879/99908509211

Practitioner`s Section

Yassir M. Samra*, James Patrick Abulencia, Emilia Golebiowska Purington***, Giovanni Kelly******

Building bridges in education: Exploring how engineering and MBA students can work together to help the environment using biodiesel

The growing demand for alternative fuels has propelled biodiesel into the spotlight as a viable solution. This case study at Manhattan College exemplifies interdisciplinary collaboration between chemical engineering and business students. It focuses on transforming waste vegetable oil into biodiesel, offering an eco-friendly fuel source and glycerin for soap and candle production. MBA students conducted a feasibility analysis for these products. Promising applications emerged: Biodiesel for generators, glycerin-based soap, and candles. This experience equips students with practical skills and emphasizes the value of engineering-business partnerships in education, encouraging cross-disciplinary teamwork and sustainable innovation.

1 Introduction

As the world grapples with the mounting economic and environmental costs associated with traditional fossil fuels and climate change caused by fossil fuel combustion, the urgency to explore alternative energy sources becomes ever more apparent (Maleki et al., 2023). Among these alternatives, biodiesel emerges as a promising contender, offering a sustainable substitute for petroleum-based fuels. Derived from natural feedstocks like vegetable oil, biodiesel presents a versatile solution to the energy crisis. It's not only capable of operating independently from petroleum but can also be blended with it, thereby mitigating the challenges posed by temperature-induced viscosity variations. This versatility is demonstrated through various blends, such as B2 (two percent biodiesel/ninety-eight percent petroleum), B5 (five percent biodiesel/ninety-five percent petroleum), B20 (twenty percent biodiesel/eighty percent petroleum), and the pure B100. Among these, B20 stands out as the most popular, as it ensures optimal engine power retention (Jamashaid et. al., 2022).

Biodiesel exhibits impressive energy output and shines as a cleaner-burning fuel, leading to substantially reduced carbon emissions compared to conventional petroleum. For instance, the deployment of a B20 blend can slash carbon emissions by a notable fifteen percent, highlighting its potential in combating environmental degradation (nrel.gov[1]).

The cornerstone of biodiesel production is the transesterification reaction (see Figure 1), a transformative process that converts waste vegetable oil into biodiesel and glycerin. This reaction involves the introduction of liquid alcohol, typically methanol or ethanol, alongside a base like sodium hydroxide or potassium hydroxide, to the vegetable oil. A valuable byproduct of this reaction is glycerin, which opens doors to diverse applications, including the production of soaps, candles, and various other products.

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[1] www.nrel.gov, "Biodiesel Basics"

ISSN 1613-9623

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URN: urn:nbn:de:hbz:6-99908518704
DOI: 10.17879/99908509211

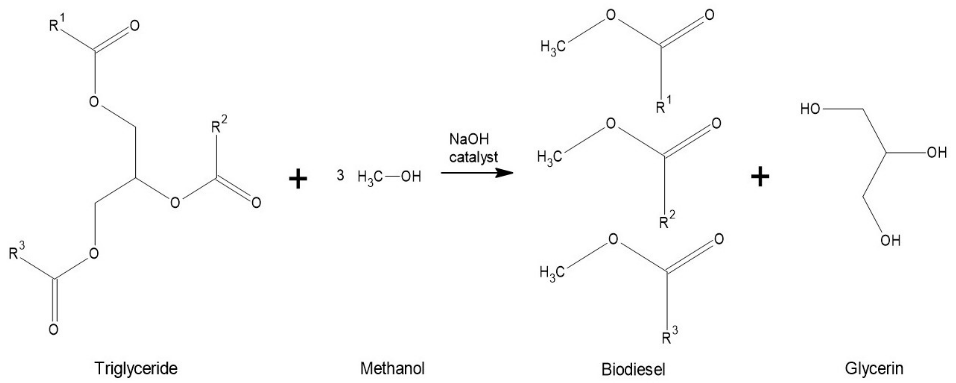

Figure 1 Transesterification Process.

Once the transesterification reaction is concluded, the extracted biodiesel requires refinement to achieve optimal purity. One purification technique involves using water, capitalizing on the non-polar nature of biodiesel molecules. Water's polarity attracts and entraps impurities, effectively separating them from the biodiesel as the two liquids separate. This washwater, laden with contaminants, is subsequently separated through phase separation. Alternatively, the application of Magnesol D-Sol, a synthetic magnesium silicate powder, offers another impurity removal avenue. This innovative method involves suspending the filtering powder within the biodiesel, where it actively binds to impurities. However, the powder itself remains suspended and necessitates an additional filtration step for its complete elimination (Berrios and Skelton, 2008).

The feedstock for biodiesel production predominantly comprises vegetable cooking oil, although other sources can also be employed. Examples encompass plant-based oils such as peanut oil, animal oils derived from animal fats, and a wide array of cooking oils (Singh et al., 2014). These sources share the presence of long fatty acid chains and esters, which can be skillfully converted into biodiesel. While certain alternative oils may possess a higher concentration of these molecules than vegetable oil, the latter remains the preferred choice due to its abundance and cost-effectiveness.

Biodiesel transcends its role as a mere alternative to petroleum, representing a dynamic solution poised to revolutionize the energy landscape. Its versatility, efficiency, and environmentally conscious nature position it as a key player in the pursuit of sustainable energy sources. To get new engineers to think about their role in the environment and sustainability, colleges can help. Colleges serve as fertile grounds for exploring the intricate dynamics of product manufacturing and assessing their economic viability due to their conducive environment for interdisciplinary collaboration, robust research infrastructure, and the inherent pursuit of knowledge-driven innovation. Engaging students in real-world projects involving the conceptualization, development, and production of various products not only facilitates hands-on learning but also encourages critical thinking and problem-solving skills. The convergence of diverse academic disciplines, ranging from engineering and business to environmental studies and chemistry, provides a rich tapestry of perspectives that enriches the process of product ideation and evaluation. This multidimensional approach equips students with a holistic understanding of the complex interplay between technical feasibility, market demand, resource availability, and cost considerations.

In the context of biodiesel production, for instance, colleges can harness their academic prowess to examine every facet of the process, from sourcing feedstock to refining end products. Through interdisciplinary collaborations, engineering students can leverage their technical expertise to optimize the production process, while business students can apply economic models to assess the financial feasibility of the venture. Moreover, the vast array of research facilities, laboratories, and faculty expertise available within academic institutions enables comprehensive analyses of product attributes, quality, scalability, and environmental impact. The academic philosophy of inquisitiveness and empiricism propels students to not only develop innovative solutions but also rigorously evaluate their potential success in real-world contexts. By immersing students in such experiential learning endeavors, colleges can impart valuable skills that empower future professionals to navigate the intricate nexus of product creation and economic viability, while fostering a culture of sustainable innovation within academia and beyond.

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2 Prior ventures

Embedded within the broader sustainability movement sweeping the nation, biodiesel production has emerged as a pivotal element of environmental responsibility. This movement has found resonance within numerous colleges and universities, fostering the adoption of green methodologies to reduce ecological footprints. Emblematic of this trend is Manhattan College, a proactive participant in this wave of change. The college has undertaken research into biodiesel production and its pragmatic integration of both biodiesel and glycerin derivatives within its campus ecosystem. Echoing this commitment, other distinguished institutions like Tufts University, the University of Missouri, and Pennsylvania State University are making strides in biodiesel research.

2.1 Tufts University's Sustainability Program:

At Tufts University, a comprehensive sustainability program is at the forefront of their agenda. Biodiesel holds a prominent position within their efforts, not just within the campus borders, but with aspirations to extend its impact beyond. The university's investigation into biodiesel encompasses its application in university vehicles, thereby aligning with their sustainability objectives (sustainability.tufts.edu[2]). Furthermore, Tufts has since ventured into the international realm, proposing a biodiesel production scheme in Turkey aimed at mitigating global warming (gordon.tufts.edu[3]). This initial proposal evolved into an ambitious business plan, meticulously scrutinized for its marketing, operational, and financial viability. While substantial strides have been taken, a comprehensive examination of biodiesel's efficiency and cost-effectiveness as an alternative fuel, and the potential to integrate its benefits across campus activities, remains to be explored.

2.2 University of Missouri's Focus on Biodiesel Innovation:

Dr. Schumacher's research endeavors at the University of Missouri have placed biodiesel at the forefront of innovation. His emphasis on soybean oil as a feedstock for biodiesel production has led to insightful revelations (Schumacher et al., 1993). Through his research, he gauged the quality differences between various biodiesel blends

and explored their potential in powering heavy-duty diesel engines (Schumacher et al., 1994). Notably, Schumacher delved into the realm of public transportation, with a particular emphasis on buses (Schumacher and Weber, 1994; Chandler et al., 1996). Emissions reductions from diverse engines, such as the Series 60 DDC engine (Schumacher, 1995) and the Cummins L10E engine (Marshall et al., 1995), were scrutinized, underlining biodiesel's potential in curbing pollution. However, while the research has shed light on the biodiesel-bus nexus (Schumacher and Gerpen, 2000), its scope has yet to encompass the broader implications of biodiesel across the entirety of the university's operations.

2.3 Pennsylvania State University's Pilot Plant Innovation:

The Pennsylvania State University's commitment to biodiesel innovation shines through its dedicated biodiesel pilot plant, tailored for batches of 25 gallons. This facility serves as a hub for multifaceted research, exploring areas such as biodiesel reactions at room temperature, methanol recovery, and the application of novel technologies like thermoelectric condensers and small-scale reactors. Their explorations have even encompassed the intricacies of biodiesel quality, pour point dynamics, and flash point analyses. Notably, the university's foray into alternative feedstocks, such as camilina oil, displays a quest for innovation. Although the university's intention to leverage waste cooking oil from its cafeterias for biodiesel production is evident, a comprehensive blueprint for implementation remains a work in progress (che.psu.edu[4]).

In sum, these academic institutions exemplify the synergy between education, research, and sustainability in the realm of biodiesel production. Their endeavors underscore the transformative potential of biodiesel as a key catalyst in advancing environmental consciousness within higher education institutions. While strides have been made, there lies untapped potential in comprehensively integrating biodiesel's benefits across campus-wide operations and exploring its feasibility beyond specialized applications.

[2] https://sustainability.tufts.edu/ "Alternative Fuels in the Tufts University Vehicle Fleet".
[3] https://gordon.tufts.edu/ "Biodiesel Production in Turkey".
[4] www.che.psu.edu

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3 Execution

With a vision to empower communities, two chemical engineering students embarked on a journey to create a viable blueprint capable of yielding abundant biodiesel energy for diverse applications. Drawing upon both virgin vegetable oil and discarded culinary oils from the college's cafeterias, the students engaged in a partnership with the Mechanical Engineering department. Collaboratively, they harnessed the power of a Lister engine to assess the efficiency of both virgin and waste-based biodiesel, measuring their prowess against conventional petroleum fuel. Their studies ventured into the realm of biodiesel purity and fuel efficiency, navigating the complex interplay of varying alcohols and bases in the biodiesel synthesis process.

Building on this, another project, undertaken by four chemical engineering students focused on the transformation of glycerin, a byproduct of the biodiesel production process, into an array of utilitarian commodities. They envisioned the creation of bar soaps, liquid soaps, and candles. As the project's trajectory evolved, it naturally dovetailed into a harmonious collaboration between the chemical engineering undergraduates and their counterparts from the business school. At a college/university that houses business and engineering schools, faculty members across the two were able to introduce students in their respective classes to this project with relative ease. Specifically, two faculty members (one from chemical engineering and one from the MBA program) provided support for students by allowing them time to meet to work with their counterparts. Together, this interdisciplinary brigade of students undertook the task of crafting an intricate cost and feasibility analysis for the array of products stemming from the biodiesel reaction. These products, poised on the cusp of realization, carried the potential to resonate with a spectrum of stakeholders within the college's vibrant ecosystem.

The significance of Manhattan College's biodiesel initiative became ever more pronounced in the aftermath of the catastrophic Hurricane Sandy's assault on New York City. Amid the storm's fury, the rending of a power line rendered two campus buildings powerless, one of them a dormitory. Cast into darkness, the dormitory's lifeline rested upon backup generators. However, the generator's roar came with a toll, both logistical and financial. Resource scarcity in the hurricane's wake, coupled with the hefty operational costs of a generator at full throttle, cast a shadow over the students' experience, depriving them of in-room power for weeks. It was in this pivotal moment that the potential of the biodiesel initiative truly came to the forefront. The conceptualized plan to harness biodiesel for the generators, forged with foresight, could have been a transformative force during the storm's aftermath, fostering uninterrupted energy supply as the campus rebuilt. Instead, the college found itself compelled to procure conventional fuel, relinquishing the opportunity to leverage its culinary discards for a sustainable solution.

4 Findings

The initial inquiry into the potential of biodiesel production was conducted to ascertain its applicability within the institutional context of the college. A significant benefit materialized in the form of addressing waste vegetable oil disposal from the college cafeterias. This investigation illustrated that the current practice of engaging external entities for oil disposal could be reduced, if not eliminated, by utilizing the cafeterias' used cooking oil. Consequently, an immediate and tangible financial gain is envisaged through the abrogation of disposal costs. Moreover, the adoption of biodiesel production from spent cooking oil holds the promise of curbing oil accumulation in landfills, thereby fostering a waste-reduction framework.

A feedstock analysis was next performed to forecast the expected outputs from the biodiesel process. This analysis revealed that the quartet of cafeterias at Manhattan College collectively yields 220 gallons of waste vegetable oil per month. Assuming a conversion efficiency of approximately 70%, this translates to the monthly production of 150 gallons of biodiesel. Over the course of seven operational months, this aggregated to 1050 gallons of biodiesel, destined for application in campus vehicles or as heating oil. The residual 70 gallons are allocated for conversion into glycerin, which holds potential for the creation of diverse commodities such as bar soap, liquid soap, and candles.

The initial phase of application assessment concentrated on the feasibility of employing biodiesel for campus vehicles. Despite its merits, this avenue was constrained by the recent acquisition of gasoline-fueled vehicles by the security department, rendering plans for an immediate switch to diesel-fueled vehicles unviable.

The next application was the use of heating oil for the backup generators. With 1050 gallons of biodiesel available, it was

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URN: urn:nbn:de:hbz:6-99908518704
DOI: 10.17879/99908509211

determined that the generators at all four of the dormitories would be able to run at the same time at full capacity for at least two days, continuously. During unfortunate and unforeseeable events such as Hurricane Sandy, this prospect holds the potential to yield substantial cost savings. By blending biodiesel with conventional petroleum fuel, an extended operational period for the generators can be realized, resulting in concurrent reduction of operational expenses. The favorable economics of producing biodiesel from cooking oil, when contrasted with procuring petroleum diesel, substantiates the feasibility of this application.

Bar soap was another application of the biodiesel process that was analyzed. Bar soap is a product of a saponification reaction where glycerin is reacted with sodium hydroxide to make soap. In order to make bar soap from the glycerin, the glycerin needs to be purified from any excess methanol before it can be molded. Because methanol has a low boiling point of 65°C (or 149°F), heating up the glycerin beyond this temperature will effectively remove the methanol. The issue lies in the use of sodium hydroxide. Even though sodium hydroxide is the necessary reactant, it does not react as well with glycerin as it would with vegetable oil. The resources required in both time and materials to produce an acceptable quality solid bar of soap indicated that the break-even point was beyond the capacity of the school (i.e. the cafeterias would not be able to provide enough used vegetable oil to make this product profitable).

After analyzing bar soap, liquid soap was analyzed for feasibility. Liquid soap also goes through a saponification reaction as did the bar soap once the methanol is removed. For liquid soap, however, potassium hydroxide is used in the reaction as opposed to the sodium hydroxide used for bar soap. When the saponification reaction is completed, the products are further cooked to maintain the soap in liquid state. In the feasibility analysis, the liquid soap would be used to stock the soap dispensers throughout the campus buildings. There are a total of 75 soap dispensers on campus which require 172 cases of soap containing six liters of soap each per year. Each case costs the school $42.50 which makes the total cost of soap $7,310 per year for the campus. The ratio of reactants to product made was scaled up to account for the total amount of soap needed to provide the college with soap for a year. The relevant data for the cost analysis is shown in Table 1.

Based on this table, the total cost of manufacturing liquid soap from glycerin comes out to be $1,137, approximately one seventh of the cost of buying liquid soap each year. This option saves the college $6,173 per year. After five years the college will end up saving over $30,000. One issue arises from the fact that the current method for making the soap takes 45 minutes from start to finish and produces only three liters of soap. One proposed solution is for the college to hire its students under work-study to produce the soap. The cost of hiring students to make soap is shown in Table 2.

Table 1 Cost to produce liquid soap on campus.

Item	Quantity	Price	Total
Plastic soap dispenser	75	$3	$225
Total packaging costs			**$225**
Glycerin	500L	$0	$0
Water	250L	$0	$0
Potassium hydroxide (2lbs.)	60	$8	$480
Lavender scent (1lb.)	16	$27	$432
Total materials cost			**$912**
Total cost			$1137

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URN: urn:nbn:de:hbz:6-99908518704
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Table 2 Cost to employ students to make soap.

Amount of soap needed	1032L
Total number of batches	344
Total number of work hours	258
Total employee costs	$1870.50

From the table above, the total cost of hiring students to produce the needed soap from the school comes out to $1870.50. Even with this additional cost, the final cost to produce soap for the whole campus is $3,007.50. With this option the college still saves $4,302.50 per year, making it an extremely feasible option.

The last option in the feasibility study was the manufacturing of candles. The components of a candle include the wax, wick, color, fragrance, and jar, which is more material than what goes into making any of the other biodiesel derivatives. To make the wax, the glycerin has to be melted down to a liquid. Color in the form of either a pigment or a dye along with the fragrance is added to the melted glycerin. The wick is then placed into the jar and the wax is poured in and set aside to cool. A major obstacle in the candle venture is that they are not allowed in any of the dormitories at this school as they are deemed a fire hazard. As a result, the manufactured candles would only be sold on holidays or before breaks. Based on the typical costs of materials for making candles, a cost analysis is shown in Table 3.

Assuming that the candles being manufactured are the smallest typical size, eight oz., the total cost to manufacture candles would be $3.32 per candle. If the candles were sold at $5.00 per candle there would be a profit of $1.68 per candle. It was determined that a total of 2586 candles would be needed every year but with supply of glycerin from the biodiesel process, only 1584 candles can be made every year. Assuming that the candles would be sold at $5 a candle the total revenue from this option is $2661.12. This option turns out to be a feasible option that can provide the school with a profit of $2661.12.

Table 3 Cost to Produce an eight oz. candle.

Type of material	Amount needed	Cost per unit	Cost
Wax	8 oz.	$0	$0
Wick	3 in.	$0.33/yard	$0.03
Fragrance	0.4 oz.	$2.99	$1.20
Color	0.1 block	$0.89	$0.09
Jar	1	$2.00	$2.00
Total costs			$3.32

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5 Conclusion

The biodiesel production endeavor at Manhattan College served as a multifaceted platform, yielding not only biodiesel but also an array of valuable commodities extracted from the glycerin byproduct. In light of this, an exhaustive feasibility analysis was meticulously undertaken to ascertain the optimal utility of both biodiesel and glycerin. The scope of potential applications encompassed utilizing biodiesel for campus vehicles, employing it as heating oil for backup generators, and harnessing the glycerin byproduct to create bar soap, liquid soap, and candles. The ensuing feasibility assessment was not confined solely to demand dynamics, but also intricately accounted for the raw material supply, manufacturing expenses, and underlying production processes inherent to each application.

Investigation into the viability of biodiesel for campus vehicles revealed an untenable proposition due to the recent replacement of the college's vehicle fleet with gasoline-powered models. In contrast, the notion of utilizing biodiesel as heating oil for generators emerged as a substantiated and practicable endeavor. The extant reservoir of vegetable oil derived from cafeterias gives ample potential to generate sufficient biodiesel capable of powering all on-campus generators uninterruptedly for a duration of two days. This proactive approach to energy provisioning is poised to set up substantial fuel cost savings, particularly during exigencies such as the Hurricane Sandy scenario, characterized by escalated fuel costs and limited supply.

Regarding the biodiesel byproducts stemming from glycerin, the feasibility analysis showed the nonviability of bar soap due to protracted processing times and inconsistent product quality. In contrast, the production of liquid soap emerged as a promising avenue. The liquid soap manufactured from the supply of glycerin would be enough to supply all the soap dispensers at Manhattan College each year. The annual yield of liquid soap, derived from the available glycerin supply, could effectively replenish all soap dispensers across Manhattan College. The temporal constraints inherent to soap manufacturing could be assuaged by engaging students under a work-study model, a stratagem that, despite incurring labor costs, ultimately realizes significant annual savings exceeding $4,000.

Conversely, the feasibility of candle manufacturing revealed incongruities in demand and supply dynamics, rendering the enterprise unfeasible. While the production cost per candle stood at $3.32, indicating potential profitability, the incongruity between the estimated supply of 1584 candles and the projected demand of 2586 candles underscored a notable demand deficit. Considering this demand-supply disparity, revenue projections for candles remained less promising.

A crucial facet of the biodiesel production project lay in the synergistic collaboration between the business school and the chemical engineering department. This interdisciplinary engagement facilitated a holistic real-world analysis. The assessment of biodiesel production extended beyond mere yield considerations, encompassing the practicality of each derivative. This symbiotic relationship gleaned mutual benefits, empowering engineers with practical business insights and endowing business students with technical acumen. Such partnerships can be effectively replicated within other institutions, wherein chemical engineering faculty can align with their business counterparts. Such collaborative initiatives could manifest as independent research endeavors akin to those delineated in this study or be seamlessly integrated into curricula, particularly within courses such as plant design enriched with an economic dimension. The cultivation of interdisciplinary interactions holds potential not only to enrich institutional prospects but also to augment the skill set of participating students.

6 Future work

In light of the delineation of the most viable biodiesel products, the imperative to formulate an actionable plan becomes manifest. Pertaining to the projected yield of 1050 gallons of biodiesel earmarked for serving as heating oil for the generators, a series of strategic determinations come to the fore. Foremost among these determinations is the selection of an appropriate storage facility for the biodiesel during periods of dormancy. With the assumption that power disruptions will be infrequent, the entirety of the 1050-gallon yield necessitates simultaneous storage provisioning. Moreover, the attendant cost of establishing and maintaining such storage infrastructure mandates meticulous evaluation.

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BUSINESS CHEMISTRY

Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518704
DOI: 10.17879/99908509211

Along with this, the establishment of a cogent production and delivery schedule emerges as a paramount requirement. This schedule should be intricately synchronized with the anticipated removal of used cooking oil from the campus cafeterias. Furthermore, to ensure a steady and sufficient supply of liquid soap at times of demand, the formulation of a comprehensive production schedule for liquid soap attains significance. Similarly, the production of candles warrants a calendrical outline that accommodates the provisioning of ample candles for students' acquisition ahead of the impending holiday season and the culmination of academic sessions.

In a prospective trajectory, the reevaluation of the feasibility of integrating diesel-powered campus vehicles within the institution's transportation ecosystem remains an intriguing proposition. This future course of action may entail a comprehensive reassessment of the prevailing campus vehicle fleet, taking into account evolving technological advancements and potential shifts in logistical paradigms. An alternative to implementing biodiesel in security vehicles is to use the fuel in less urgent vehicles such as with physical plant services.

In essence, the delineated biodiesel initiatives not only hinge on the identification of feasible products but also necessitate the formulation of meticulously orchestrated operational strategies that span across various temporal horizons. Such strategic orchestration is intrinsic to ensuring optimal utilization of resources, maximizing the realization of projected benefits, and fostering a sustainable integration of biodiesel-based applications within the campus environment.

Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518704
DOI: 10.17879/99908509211

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JOURNAL OF
BUSINESS CHEMISTRY

Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518869
DOI: 10.17879/99908515764

Commentary

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Intercultural leadership – A need for now and the future in chemical industry. A personal observation based on experience.

1 Introduction

"The world is small today" and "the number of multicultural teams increases every day. Consequently, cultural wisdom has a huge impact on increasing team performance" (Karayel, 2021).

Cultural Wisdom is a key competence factor in today's Business, but seems still heavily underrated regarding importance and steering in Industry. "Cultural wisdom means having curiosity towards different cultures, respecting their points of view, daring to learn from differences with an open mindset and integrating cultural intelligence in a way that creates harmony in the team" or organization (Karayel, 2021).

In today's career picture of a leadership role in a globally active company, intercultural leadership tasks are increasingly becoming the standard in two respects.

1. It is important to ensure that foreign delegations are successful. These assignments should be prepared by exploratory visits, pre-departure culture training including accompanying families, accompanied during the assignment by post-arrival training/coaching and finally include re-entry training before the return, also here including accompanying families (Gibson, 2021).

2. It is important to ensure that global and intercultural teams, which often work together virtually, can be successful and harmoniously efficient. It happens more and more often that in the middle of a career one is suddenly promoted from a local leadership role to a leadership role that has to take multicultural aspects into account, directly impacting a global team.

Both cases described call for "intercultural leadership" and, in my experience, should be prepared and controlled with appropriate development measures for the respective leaders. Today, these take place selectively in the corporate environment, but in my experience they have a clear need for optimization.

Here is the attempt to deliver perspectives to improve the situation.

First personal global leadership experiences

Immediately after finishing my PhD work as a chemist in Germany, I moved to Boston for doing academic research at Harvard University for two years. I had my family with me. We were not prepared at all at that time, neither with a pre-visit nor by a pre-departure training. And indeed, we were heavily caught by surprise. We started learning, daily and step-by-step. A lot of learnings were exciting, explorative, but some experiences were also quite embarrassing, because we just were not aware of some "unwritten rules". U.S. and German behaviours seemed so similar to us from a helicopter view, but down on earth in detail, they were not.

Another important reality at that time was the fact, that my research environment was truly global. The members of the research group came from all over the world and I met and worked together with people with twelve different nationalities during that time, ranging from India to China and Taiwan, from Australia to Canada and Europe including France, Italy and happily another German member. And some Americans as well. This was from 1988 to 1990 and gave me a pre-sense, what it means to deal with different cultures in a common team. It was a time of continuous learning.

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URN: urn:nbn:de:hbz:6-99908518869
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I was not aware then, but today I know, that this early stay abroad prepared me well for an intercultural leadership role. Cultural observations and intuitions date back to this time and a foundation was built to enhance my cultural wisdom.

Years later, I was in a mid-career situation at a big corporation, I had been working closely for a few days at an integration workshop after an acquisition with a Mexican engineer who was at home in Texas. Obviously, I did not correspond to his expectation of a German chemist. He was surprised and might have thought I had a different cultural background, which was not the case. I took his personal question, “Bernd, are you really German?” as a big compliment, but it also highlighted to me that there were different expectations of cultural stereotypes in the room.

Global leadership challenges

During my professional career, on the way from plant manager to global manufacturing leader, I suddenly faced a significant challenge when I became responsible for production plants with employees from different countries and cultures across the globe. I took on a mix of different work cultures also, because the division had emerged from two different acquisitions. The respective site leaders were directly reporting to me and came from eight different nations.

I can still remember that I was just overwhelmed with the cultural complexity of my team. My employees were spread over different nations around the globe. From China to U.S., from Singapore to Canada, from Spain to Sweden, Netherlands and Germany. And nevertheless, we had to work together across all national boundaries and only virtually with not more than one face-to-face-meeting per year. We all had to produce the same products with the same or similar properties, with best possible quality. And we had to do this safely without accidents and incidents and with best available technology, where we owned the intellectual property through patents and process know-how. We were a global team and we all wanted to be successful and harmoniously efficient.

Learning was the order of the day. On-the-job. However, there was neither an official guidance from the Corporation nor an easily available guideline in literature – on my first view. So, I was prompting an Internet search on “Intercultural Leadership Excellence”, as this is what I was looking for. What I found was an excellent external support, a mentor and cultural mapping literature. I was reading first about leading across cultures (Lewis, 2006) and learned later also about Erin Meyer`s culture mapping tool (Meyer, 2014).

Although, I had my intuition and brought knowledge and experience gained from my early stay abroad, it wasn’t until I read Lewis‘ book, that it fell like scales from my eyes. Although understanding the risk of reinforcing stereotypes, Lewis‘ three-types-model provided me with important insights into possible behaviours of the members of my global team. It gave me hints on how to develop steering elements to be taken into consideration, also during multinational team-meetings.

Lewis‘ model differentiates between three leadership/ communication styles and maps those depending on cultural origin.

- Linear-Active, task-oriented highly organized planners
- Multi-Active, people-oriented loquacious inter-relators
- Reactive, accommodating and respect-oriented listeners

The focus had to be on people and their behaviours. I understood the typical stereotype behaviour of a German in an almost fully linear-active mode versus the multi-active very people-oriented style of the Mexican and Spanish members of my team and also versus the reactive, very careful listeners of the Chinese members. It was all about to understand the behaviours of the team members in dependence of their culture, which was built on respective values and their education.

I approached this topic of “intercultural competence“ in such a way that I first dealt with stereotypes of cultures, understanding clearly, that it was a generalization that wanted to be reflected and adapted in the respective individual contact. Because in the end it is always an individual view and it depends on the ability to change perspective, to be able to ask empathetic questions and to be tolerant of contradictions. Zooming then into individual and personal styles of my team members, was a listening exercise and a learning process. My goal was to develop the ability to understand, value and trust my employees in their respective cultures and to be able to pass on these insights to my direct reports as well, always having the idea of a true virtual team in mind.

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I introduced specific cultural trainings (including for myself) and I organized a physical meeting once a year so that the virtual conference calls got a real face and workshop elements could be used for intercultural exchange. Since then, cultural trainings and workshop elements for intercultural exchange have been an integral part of the team building process of my organizations. Some typical learnings depicted on respective flipchart pages read as follows:

- Learn to read and interpret body language.
- Understand each other demands and communicate about the expectations.
- Take time to explain the "rules". Time consuming, but important.
- Be willing to learn about other rules, adjust to the environment, be flexible.
- Be open-minded, learn about other culture, travel.
- Be willing to listen
- It is all about TRUST.

Building mutual understanding and finally building trust was the objective.

Success factors to increase performance of a global team

Cultural wisdom

Cultural wisdom has to be developed in an exploratory way, not only in the bi-cultural relationship, but in the entire diverse team of different cultures.

In fact, travel opens up new horizons. Especially when it comes to countries where you own responsible management tasks. For example, when I mentioned at the plant in Nanjing, for which I was responsible for among other plants, that I was planning a three-week holiday trip to China together with my family, this had a very positive influence on my standing at the plant and opened up many opportunities for private exchanges of conversations. The Chinese employees were so proud that I was exploring their home country in my private time and together with my family.

National Heritage or Art History are on occasion a beautiful addition to a business trip. It is particularly impressive, when historical events can be seen in the context of a different point of view as personally experienced in the National Museum of Singapore in a country being a melting pot of many Asian cultures. Some understanding of historical circumstances will increase the ability to listen and to participate in small talks to this topic.

Listening and learning is the order of the day, and to connect with the local employees. I planned and used small talk topics. Because: Small Talk is Big Talk. Sport as a topic almost always works. Personal topics from family life are also confidence-building measures and important to learn more about the daily life of your counterparts. And one will also find opportunities to learn from other cultures and adapt best practices (see for example Hiller, 2022). Making connections is the be-all and end-all.

One more example: I have had the opportunity to be involved in the trainee program of my former employer. Recruitment interviews, accompaniment, mentoring. Our candidates for the Frankfurt office were international and came beside Germany from many other parts of the world. I gladly took this opportunity to educate myself. One of my favorite points of discussion was the question of how I would best find an introduction to the respective culture of my counterpart's home country. The learnings from those conversations were often real eye-openers.

"Look for opportunities to increase your cultural intelligence level as much as possible. The more you learn about different cultures, the more inclusive you will become" (Karayel, 2021). And this will have a strongly positive impact on team performance.

Ambiguity tolerance

New behaviors, often contradictory to one's own instilled, had to be applied and adapted to the situation. Be tolerant for ambiguities, be able to ask empathic questions and understand the importance of the change of perspectives. This combination of social competencies is described by Anna Fuchs as core for intercultural (she calls it transcultural) contacts. A transcultural attitude goes hand in hand with the invitation to both accept differences in perceptions, perspectives and competencies and to discover them as resources in order to expand one's own perspectives and possibilities for action (Fuchs, 2022).

My site visits in Mexico were always accompanied by surprises. Important information of respective challenges

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could have been shared easily before my travel. But it was not, because difficult messages to convey are better to be done in their minds face to face. I accepted that and was always prepared for one or more unexpected explanations when I showed up.

My skip level team meetings in Sweden were always quiet, when I took over responsibilities there. Not much discussion in the room. I thought so. In reality, I could not endure periods of silence, just a few seconds usually. The response time to questions in Sweden is longer as I was used to. After I learned that, the discussion had been quite lively.

During my numerous business trips to Dallas, Texas in U.S., I had become accustomed to a ritual. I usually worked five to six hours during the ten-hour flight from Frankfurt, Germany. But the last two hours of flying I watched an actual movie in the original American version. This not only helped me to listen, it actually transformed me a bit into a different way of thinking and behaviors. I actually became more relaxed, more spontaneous and was also more in the mood for a little joke – changing from my German Me to my American Me.

Sensitivity in language use

Positions in the team had to be conveyable in a balanced way for everyone. For almost all of my team, including me, English was the second language. And that was a good thing. It helped. Promoting inclusive communication is a leadership task.

The real learning began during my professional career in a global Chemical Company, based at Dallas, Texas. First thing to understand were the multiple idioms and what they really mean. “It’s not rocket science”, “in a nutshell”, “ballpark figure”, “no-brainer”, “on the back-burner”, just to name a few. Some of my favourite learnings as compared to the quotes of a workbook for effective communication in a multilingual world (Gaynor and Alevizos, 2019).

- Recognize what filler words you use. Avoid the temptation to fill every gap in the conversation. Adding pauses is a good way to adjust the pace of your language (pages 10, 13).
- If using an idiom, try to paraphrase to make the meaning clear, for example, “Shall we call it a day?” means “Shall we stop?”, (page 17).
- By including rather than excluding other languages, non-native speakers have the chance to express ideas or concepts that they may have difficulty articulating in English (page 32).
- Sharing a joke can seem like a good way to defuse a difficult situation or just put people at ease. Be aware, though, that different cultures find different things funny (page 46).

Looking back, I either had discovered topics that I did intuitively the right way or I spotted items, that I should have done the way described. And in addition, I found the list of idioms, a lot, including those mentioned above (page 57ff).
In my experience, it is very helpful, to find workbooks with valuable examples, written in a handy and concise way for busy leaders like me when I was leading a team with members spread from eight different nations around the globe. There is general not much time to reflect on topics other than those closely related to the “real” business topics. One has to function. Period. It is a question of behavioral discipline to protect oneself from falling back into one-dimensional cultural behaviors, due to high stress. How this can be achieved, is described elsewhere (Scharbert, 2009).

Conclusion

The management and performance measurement of foreign delegations in companies are still often neglected. And even more so the preparation of managers when they take over a globally composed team.

The focus on Diversity, Equity & Inclusion (DEI) has shed some light on the cultural side of diversity and thus drawn attention to the topic of “intercultural competence“. However, the step towards intercultural leadership excellence and the associated leadership development would have to be initiated much more broadly.

And where is the business case for this? This is indeed a good question, which will be answered when more data has been collected in comparison. In any case, I am convinced that it will pay off if managers of international teams go through an appropriate development curriculum.

So, what is to be done? Courses on the subject are available at universities and colleges and continue to grow. What is lacking are the offers of education and training for those

ISSN 1613-9623

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URN: urn:nbn:de:hbz:6-99908518869
DOI: 10.17879/99908515764

who, in the course of their professional development, suddenly and sometimes unexpectedly face the challenge of a global leadership role, mostly in mid-career.

Furthermore, more focus needs to be placed on the support and control of the training process with regard to the development of intercultural leadership skills within the companies. That also would be a pre-requisite for a relevant data collection to be used to identify what a successful intercultural leadership role performance looks like.

In a global leadership role, I used my available budget wisely also for intercultural trainings for my team and myself. And before accepting a delegated role abroad, I actively researched respective professional cultural mentoring for me and my family.

Learning is the order of the day.

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JOURNAL OF
BUSINESS CHEMISTRY

Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518522
DOI: 10.17879/99908508038

Commentary

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Book review – Chemistry Entrepreneurship

When we held this book in our hands for the first time, we were surprised as to the reason someone had made the effort to compile another such book with already so many similar titles available – especially in such a small niche as chemistry. Right in the first sentences of the preface, the focus of chemistry entrepreneurship is widened to "adjacent disciplines" without going into details about who might be meant by this. As one of their motivations, the editors describe in the introduction that such a book would have been of great assistance when García-Martínez started his first chemistry start-up in 2006. With the experience of having founded a chemistry company themselves, the editors emphasize the relevance of chemistry start-ups to solve problems of our time such as material innovations and climate change and want their book to inspire chemists to start a company. The editors emphasize the fact that many chemists receive little or no training in how to start a company based on their scientific endeavors, even though this would be of importance to society. Finally, the editors note that the present book is intended to be much more of a practical guide for chemists and chemical engineers than an academic study on how to start a business.

The table of contents makes it clear, quickly, that the contents of the book were indeed broader in terms of topics and target groups than the book title and introductory words suggest. Under the headline "We Need An Entrepreneurial Culture in Chemistry: Do You Have What It Takes to be a Chemistry Entrepreneur?", chapter 1 deals with the topics of start-up ecosystem and culture, the particular difficulties and challenges of starting a company from the academic chemistry environment and tells in a very stimulating and exciting way how chemistry start-ups have changed our society in the past.

The title of Chapter 2 – "Taking Ideas Out of the Lab: Why and When to Start a Company in the Biomedical Field?" – already makes you wonder: are bio-medical and chemistry start-ups the same? Does not the title of the book itself suggest that chemistry start-ups are so special that an entrepreneurship book, just for them, is necessary?

Chapter 3 – "In Pursuit of New Product Opportunities: Transferring Technology from Lab to Market" – adds to the confusion at first glance. However, both chapters are extremely exciting by themselves. As all chapters, they are written by experienced practitioners and entrepreneurs describing numerous case studies, revealing many practical tips, and providing inspiration to upcoming entrepreneurs. However, the reader has to accept that they are not explicitly and exclusively about chemistry start-ups.

Chapter 4 with the title "Financing and Business Development for Hard Tech Startups" provides an overview of investors, their expectations, and how they feel about hard-tech start-up companies. Apart from the fact that "hard-tech" remains undefined and that it is up to the reader to see the parallels, this is a very important and well-done chapter. Here, company founders get to know investors as "customers" with a slightly different understanding of the product, who want to deal with market opportunities rather than with technical details. Capital raising is a relevant topic right from the beginning since chemistry start-ups usually are intense regarding the investment necessary.

Chapter 5, titled "Battery Entrepreneurship: Gameboard from Lab to Market", again deals with a specialty that is of great added value for everyone who plans to start a company in this field of technology. For those who expect further insights into the challenges of a chemistry start-up, it must be said that much transfer of knowledge is necessary to recognize the parallels and references. The case studies are about applications such as medical devices, drones, aircraft, shipbuilding, the automotive, and the energy industry and

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Vol.20, Iss.3, October 2023
URN: urn:nbn:de:hbz:6-99908518522
DOI: 10.17879/99908508038

thus offer a broad view of the value-creation chain of chemical products. Here, at the latest, it becomes clear that the term "chemistry entrepreneurship" is used broadly, implying, that almost every tech start-up deals in principle with chemicals or products derived from the chemical industry. However, we consider this to be of little assistance in understanding how start-up companies emerge from chemical research.

Chapter 6 – "Growing a Business in the Chemical Industry" – deals with the market environment and characteristics of the chemical industry. Above all, the author discusses the fundamentally important topic of the relationship between invention (solution) and the corresponding problem of potential clients. The author points out that without a corresponding problem, there is little chance of the idea successfully entering the market. Although the chapter also provides some explanations and tips for the later phases of a start-up, it is primarily interesting to anyone intending to start a company and early-stage company founders.

Chapter 7, titled "New Models to Foster Big Pharma and Chemistry Entrepreneurship", begins with the challenges for start-ups when it comes to cooperating with large companies in the pharmaceutical industry. However, there is no clear distinction from companies whose target group is the chemical industry. As before, the reader has to ask himself whether pharmaceutical companies operate in the same way as technology companies outside the healthcare sector. Thus, the chapter is just right for those who envisage their market entry into the pharmaceutical industry, but not helpful for the many other chemistry start-up founders who want to develop their products in cooperation with established companies from the chemical industry.

The last chapter – "The Economic Need for Chemically Based Start-Up Companies" – is more a chapter for political decision-makers in the US than for company founders from around the world. Even if it does not hurt for US-based company founders to understand their financial environment and the funding landscape, we believe this chapter is of little help to international readers and for the task of building a start-up company in general. However, the politically motivated reader will find examples and may be inspired by their projects.

In summary, "Chemistry Entrepreneurship" is a strong and necessary book with a multitude of case studies that honor the fact that, in addition to some generally valid findings, it is the diversity of cases that can encourage and inspire the reader. We are convinced that "Chemistry Entrepreneurship" is an exciting book for all natural scientists and engineers and early technology entrepreneurs in general. However, we hope that non-chemists will not be put off by the somehow too specific title.

Chemistry Entrepreneurship
By Javier García-Martínez and Kunhao Li
Wiley-VCH, 2022, 268 p., hardcover, 99 €.
ISBN 978-3-527-34544-1

JOURNAL OF
BUSINESS CHEMISTRY

ISSN 1613-9623