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Sustainability Across the Supply Chain: A Case Study in the Automotive Industry

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SUSTAINABILITY ACROSS THE SUPPLY CHAIN: A CASE STUDY IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT

The United Nations Sustainable Development Goals have been widely adopted and implemented by organizations worldwide. However, with 17 goals and 169 targets, the decision on what to focus on and invest in are not trivial tasks. This research focuses on a major Tier-1 automotive supplier, here identified as CMF. With annual sales of 16 billion euros (2021), one in every three vehicles in the world is equipped with some form of CMF technology. The objective of this research was to evaluate CMF's value chain and understand the challenges and opportunities related to the United Nations 17 Sustainability Development Goals (SDGs). To fulfill this goal considering that sustainability is better understood when evaluated across the supply chain, we investigated 41 companies that were part of CMF's supply chain, including 14 customers that together represented about 70% of CMF's revenue, 14 suppliers, 9 competitors, and 4 other OEMs indirectly related to CMF's supply chain. A mixed-methods approach was adopted. Primary data was collected involving interviews and site visits in the US and Europe. Thousands of pages of companies' reports were used as secondary data and analyzed using qualitative and quantitative approaches. Results show that CMF's customers focus mostly on SDGs #7 (71%), #9 (71%), and #13 (71%). Suppliers' main focus was on SDGs #12 (77%), #13 (69%), #11 (38%), and #3 (38%). CMF's competitors' main focus was on SDGs #13 (88%), #12 (77%), and #6 (66%). Taking all of that into consideration as well as CMF's strategic position within its value chain, we provided recommendations for CMF going forward to focus on three main SDGs. With respect to aligning specific goals highlighted throughout the supply chain, SDG 13 Climate Action is the area of highest overlap. Considering CMF's strategy to become a leader in sustainability across the supply chain, SDG 4 Quality Education and SDG 17 Partnerships for the Goals were also identified as the main focus.

Keywords: Sustainable Development Goals, SDGs, Automotive Industry, Supply Chain Management

INTRODUCTION

Developed in 2015 as an evolution of RIO 92's Agenda 21 and the eight Millennium Development Goals (United Nations Development Programme, n.d.), the United Nations Sustainable Development Goals (SDGs) have been widely adopted worldwide. Since its inception, the 17 UN SDGs were created from a global partnership between 192 countries plus the European Union to fulfill a "supremely ambitious and transformational vision" and aim to have specific and measurable targets that could serve as a road map and plan of action to address issues in all

three spheres of the triple bottom line: people, planet, and prosperity (United Nations, n.d.; Rowe, 2020).

After almost a decade, 27 more countries and many thousands of public and private organizations worldwide have adopted the SDGs and are taking action to help advance the goals toward the 2030 deadline. For example, Strietman (2020, March 12) highlights a group of seven major companies that were investing in the SDGs understanding that it was an opportunity to do what was right for society and the planet, making a positive impact, influencing other organizations,

while also attracting commitments from climate-conscious investors (Huawei, Nike, Kimberly-Clark, Lego, JetBlue, Discovery Channel, and Hilton Hotels). Arizona State University widely published the news that it was ranked number one in the US and number two in the world for global impact through its actions addressing the 17 SDGs (Terril, 2022, April 27). During an announcement about a partnership with a regional economic development agency, Andretti Autosport highlighted their work with Formula E and how their actions are pioneering the industry in the fight against climate change through the transition to clean energy: “Formula E is the first sport to be net-zero carbon from inception, signing up to certified Science-based Targets and ensuring the sport’s ecosystem and partnerships are directly aligned to nine of the 17 UN Sustainable Development Goals” (Thomas, 2022, April 7).

As transportation is one of the main contributors for CO2 emissions, it is expected that the automotive industry will place great emphasis in adopting the SDGs as an important benchmark for sustainability practices. This paper is based on a real case of a major automotive Tier-1 supplier, here identified as CMF. With annual sales of 16 billion euros (2021), one in every three vehicles in the world is equipped with some form of CMF technology. The company had assembled a team and had a large budget allocated to be invested in the UN SDGs. However, the company was struggling in understanding what should be the focus of such effort and resource allocation. That was not a surprise because with 17 goals and 169 targets, the decision on what to focus on and invest in are not trivial tasks. In the spring of 2019, the authors met with CMF’s Director of Community and Employee Involvement. In that interview, the director explained that CMF’s focus on sustainability was evolving as a whole for the group worldwide and increasing emphasis on

“...focusing increasing global attention on sustainability and corporate social responsibility issues could impact the alignment of employee expectations in the work environment, especially with the current tight labor market.”

sustainable products and practices. She understood that focusing increasing global attention on sustainability and corporate social responsibility issues could impact the alignment of employee expectations in the work environment, especially with the current tight labor market. The fact that she was able to witness a growing alignment among stakeholders on how to deal with those topics made the director feel good about the future. She was particularly excited about the opportunities presented at CMF in North America to work aligned with the United Nations on the SDGs.

However, the same points that were promising were also the most challenging. CMF had partnered with the United Nations and committed to supporting the achievement of the 17 SDGs by 2030. Even more than 11 years before the due date, the company understood the complexity of what they were trying to achieve. In that sense, this research aimed to answer the following research questions: Which of the 17 SDGs should CMF focus on? What was the right mix of SDGs? How could CMF find the right balance of resources devoted to working with the UN on the SDGs to add value to CMF’s customers, employees, and other stakeholders, both on a regional and global scale?

With all of the above in mind, the objective of this research was to evaluate CMF’s value chain and understand the challenges and opportunities related to the SDGs. To fulfill this goal, considering that sustainability is better understood when evaluated across the supply chain, we investigated 41 companies that were part of CMF’s supply chain, including 14 customers that together represented about 70+% of CMF’s revenue, 14 suppliers, 9 competitors, and 4 other OEMs indirectly related to CMF’s supply chain.

THEORETICAL BACKGROUND

SUSTAINABLE DEVELOPMENT GOALS AND SUPPLY CHAIN MANAGEMENT

The General Assembly of the United Nations adopted the 17 Sustainable Development Goals in September 2015 (Figure 1) as part of the

2030 Agenda for Sustainable Development. They were adopted with a planned 15-year life cycle beginning in 2016, addressing a range of interconnected global challenges with an overall goal of a better and more sustainable future for the planet (United Nations Development Programme, n.d.).

Figure 1

United Nations Sustainable Development Goals



Source: United Nations Development Programme (n.d.)

The goals are interconnected as a whole and will demand action from actors ranging from governments to private businesses to individuals if they are to be achieved by 2030, or at all. Each plays a role at its unique level. Achievement will require laws and regulations from governments and international cooperation between them; businesses will need to change their culture and processes, and the average person will need to change routines that can prove to be detrimental on a global scale.

The importance of organizations working together and considering the impact of their decisions both upstream and downstream of the supply chain have been constantly highlighted in literature (Mentzer et al., 2001; Lee, 2004;

Carter et al., 2015). More recently, authors have been focusing on how to address the challenges of incorporating the SDGs in the supply chain context (Zimon et al., 2020) and exploring the role of focal companies in SDG adoption and dissemination (Pohlmann et al., 2020). A global business, like CMF, has the unique ability to be a catalyst for the dissemination and adoption of the SDGs throughout its supply chain and beyond. The actions that they take have a positive effect both upstream and downstream in their supply chain, including the opportunity to influence their suppliers by demanding changes to meet the goals on which CMF ultimately chooses to focus. A supplier failing to meet these goals breaks the push toward reaching the global SDG agenda just

as CMF would be failing to comply with standards set by its customers. CMF also has the ability to influence change on an individual level with its own employees through cultural changes within the organization. The idea would be that simple habits and routines that an employee picks up at work (since it is required there), would be carried down into their own homes, because it is now routine and ordinary to the employee. The UN talks about how “even the laziest person” has a role in meeting the SDGs on a global scale and the employer can provide the nudge needed to spark routine changes at home to match what is expected in the workplace.

METHODS

DATA COLLECTION

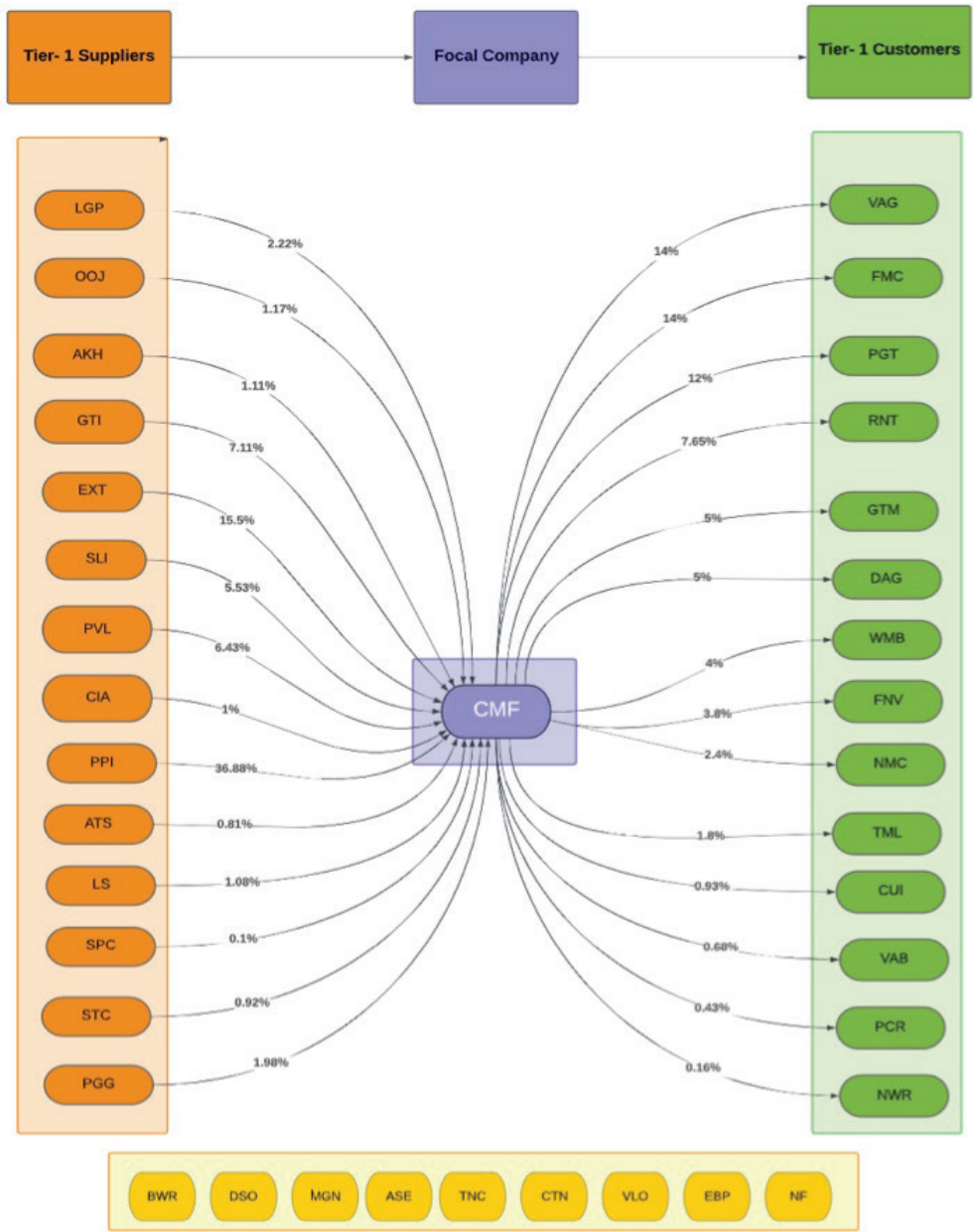
Data was collected using primary and secondary sources. Primary data was collected involving interviews and site visits in the US and Europe. Site visits and interviews were conducted at the focal company’s American and German headquarters. Site visits were also performed in four European OEMs, considered Tier-1 customers.

Secondary data was collected from both quantitative and qualitative levels. From a quantitative level, the first data point used was the identification of a financial relationship between the focal company and its main customers and suppliers. We used

Bloomberg Terminals as our main source of evidence of supply chain relationships based on financial information. The Bloomberg Terminal provides supply chain analysis information both in chart and table forms. In the chart, suppliers are located on the left end and customers on the right. CMF as the focal company is located in the center.

Figure 2 illustrates the data collected representing the most important suppliers and customers to CMF based on percentage of revenue. When the arrow goes from CMF to one of its customers, it means that x percentage of CMF’s revenue comes from the relationship with that customer. For example, of everything that CMF sells, 14% of its revenue comes from the relationship with VAG. When the arrow points to CMF, the percentage indicates CMF’s relative financial importance to that supplier. For example, from everything that PPI sells, 36.88% comes from their relationship with CMF, in other words, CMF represents 36.88% of PPI’s revenue. The companies at the bottom represent CMF’s competitors. In total, we investigated 41 companies that were part of CMF’s supply chain, including 14 customers that together represented over 70% of CMF’s revenue, 14 suppliers, nine competitors, and four other OEMs indirectly related to CMF’s supply chain.

Figure 2
 CMF's Supply Chain



Source: The Authors, based on data from the Bloomberg Lab (Bloomberg L.P., 2019)
 Note: all companies' names were disguised to protect their privacy

After the financial relationship was used to identify the main companies in CMF's supply chain, the next step was to understand what sustainability practices they were adopting and how these were related to the UN SDGs. For that, we downloaded all available

company reports and SEC 10K filings. Thousands of pages of these reports were used as secondary data and analyzed using qualitative and quantitative approaches. Table 1 illustrates the different data sources used in this research.

Table 1

Data sources

Company	Interviews & Site Visits	Company reports and/or SEC filings
Focal Company	Yes (6 including US and Europe)	Yes
Suppliers		Yes
Customers	Site visit in Europe	Yes
Competitors		Yes

DATA PRESENTATION

The suppliers and customers were chosen for inclusion by Relationship Value and Percent Revenue, while competitors were chosen by market capitalization, all as given in Bloomberg (Bloomberg L.P., 2019). Tables 2, 4, and 6 present all three metrics for suppliers, customers, and competitors, respectively. In all cases, their real names were disguised to protect the companies' privacy. For suppliers and customers (Tables 2 and 4) percentage of revenue from CMF and the actual relationship value (in millions) was also reported. Finally, in all three of these tables, the presence or absence of each individual SDG in the aforementioned reports

was indicated by company. If a certain SDG was identified in the company report, a number '1' was used to indicate its existence. If a specific SDG was not identified, a zero indicates its absence.

SUPPLIERS

The size of suppliers ranged significantly, from \$30.97 million in market capitalization to \$6.18 billion in market capitalization and was a mix of both private and public companies. A total of 14 main suppliers were analyzed in this report. We were able to uncover varying levels of insight into each company's focus on SDGs, with some having a clear outline included on their website or within their financial reporting.

Table 2

Supplier data presentation and SDG analysis

Role: Supplier				Sustainable Development Goal														Comments			
Name	Mkt Cap	% Rev	Relationship Value (\$M)	1	2	3	4	5	6	7	8	9	10	11	12	13	14		15	16	17
LGP	\$ 87,530,000	2.22	23.76	0	1	0	0	0	1	1	1	0	0	0	1	1	0	1	0	1	Information directly from the company report or website.
OOJ	\$ 60,560,000	0.01	20.12	0	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0	0	Information directly from the company report or website.
AKH	\$ 1,260,000,000	0.01	16.69	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	1	Information directly from the company report or website.
GTI	\$ 214,450,000	0.07	15.81	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0	Information directly from the company report or website.
EXT	\$ 30,970,000	0.16	14.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No reference to any of the SDGs on website or in annual report
SLI	\$ 142,930,000	0.06	12.57	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	Information directly from the company report or website.
PVL	\$ 1,260,000,000	0.06	10.24	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	Information directly from the company report or website.
CIA	\$ 1,510,000,000	0.01	7.57	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	Information directly from the company report or website.
PPI	\$ 6,180,000,000	0.37	5.68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No reference to any of the SDGs on website or in annual report
ATS	\$ 3,540,000,000	0.01	4.73	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	Information directly from the company report or website.
LS	\$ 757,860,000	0.01	4.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No reference to any of the SDGs on website or in annual report
SPC	\$ 3,110,000,000	0.00	3.06	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	Information directly from the company report or website.
STC	\$ 952,830,000	0.01	0.99	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	No reference to any of the SDGs on website or in annual report
PGG	\$ 4,980,000,000	0.02	0.93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Annual report states that sustainability reporting has been completed and is on the website, but the link included/searching the website returned no information.

An example of those with clear reporting was AKH, one of the top three suppliers by relationship value, which had specific sustainability reporting published in 2019 for 2018. The report was not organized by SDG, however, many initiatives were clearly aligned with the goals. SDG 2: Good Health and Well-Being is included in a very traditional way in a section entitled Health and Safety, which highlights improvements to in-plant metrics such as Days Away and Restricted/Transferred Cases. Perhaps even more in keeping with the goals, the report highlights a program developed by AKH to provide health and social services to the greater community. SDG 7: Affordable and Clean Energy is exemplified by their commitment to an annual increase in use of renewable energy sources in the years 2015-2018, up by over 30% during this period. SDG 12: Responsible Consumption and Production is featured in a variety of ways throughout the report: Reduced overall energy usage, reductions in process water, annual increases in percentage waste recycled across all plants, and reductions in waste generation, to name a few. SDG 13: Climate Action is also addressed at length. AKH produces in a notoriously carbon-intensive field, and the company has chosen

to participate in enhanced emissions reporting and analysis, with a plan to have a 10% reduction in scope 1 greenhouse gasses by 2025 (2105 baseline) and additional actionable items in place by 2021. Finally, SDG 17: Partnerships for the Goals is included, highlighting projects aimed to reduce pressures to the municipal water systems at multiple facilities. All suppliers were analyzed in a similar way for examination of trends.

As shown in Table 3, the most prioritized SDG among the suppliers were SDG 12: Responsible Consumption and Production (77% of the companies analyzed) and SDG 13: Climate Action (69%). The high concentration of SDG 12 and SDG 13 included within the supplier's sustainability efforts is a strong indication that these are highly prioritized, and provide an opportunity for CMF to align with the majority of its suppliers, even by focusing on a couple of SDGs. It is important to note that Climate Action could come in many different forms; ranging from improved recycling efforts, increased emphasis on solar energy, to reduced CO2 emission targets.

Table 3

Top SDGs by Supplier Inclusion

SDG	Description	Inclusion
12	Responsible Consumption and Production	77%
13	Climate Action	69%
11	Sustainable Cities and Communities	38%

Of the suppliers analyzed, it bears mentioning that the two companies for which CMF represents a significant revenue concentration, PPI (36.9% of revenues) and EXT (15.5%), do not appear to provide details on their sustainability efforts (if any). It may be worthwhile to conduct additional research on these companies, to confirm if any sustainability practices are in place. If they do not, CMF's role as a significant customer could influence them to better align their sustainability practices moving forward.

CUSTOMERS

In addition to the analysis from the Bloomberg Terminals (Bloomberg L.P., 2019), indication of top customers from graphics viewed at CMF's site visit in September 2019 was used to inform customer selection. A total of 14 main customers were analyzed in this report. Together, these accounted for over 70% of CMF's overall sales based on Percent Revenue as listed by Bloomberg L.P. (2019).

All but one customer investigated had a sustainability report available via their website and company reports (see Table 4), and most appear to update them annually. Those reports were read and analyzed for participation in each individual SDG. Those customers based in the United States showed a strong trend towards SDG emphasis and a relative uniformity of reporting style. Some US based customers, namely FMC, FNV, and CUI, specifically labeled initiatives by SDG impacted. While most major customers outside of the US had some level of sustainability reporting, the syntax and style varied widely. Several mentioned commitments to the UN

SDGs, but had less emphasis within the report as a whole. This introduced a level of subjectivity in the analysis as there is overlap between some of the goals, and different readers may interpret initiatives differently. For example, both FMC and FNV list research and development pertaining to connectivity - also an industry trend identified by CMF during our visit to the German headquarters - within their sustainability reports. FMC has it categorized as impacting SDGs 3, 6, 7, 11,12 and 13, but FNV lists it as impacting 7, 9, 11, 12 and 13. While this is significant overlap, it is still not exactly the same.

Table 4

Customer data presentation and SDG analysis

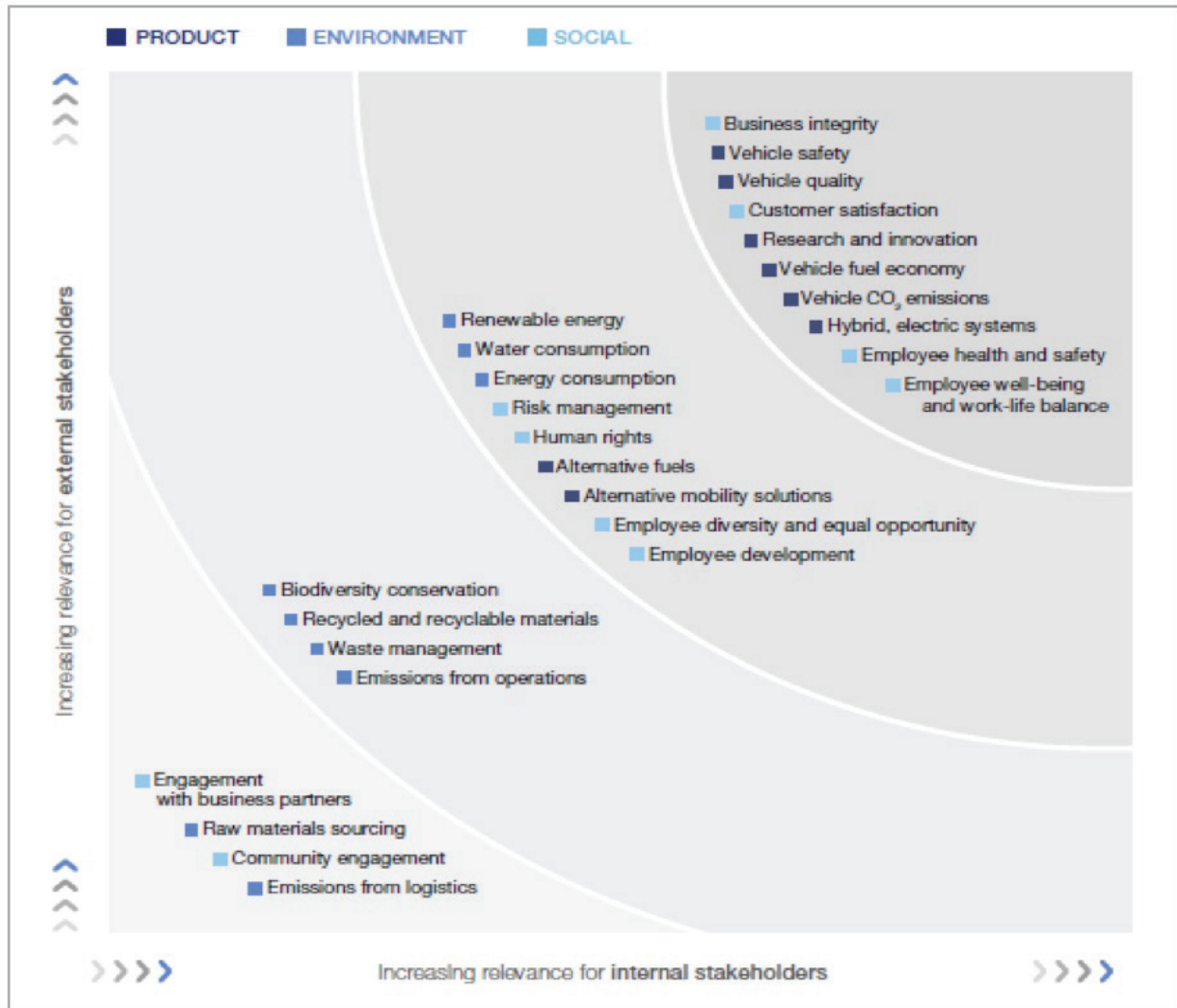
Role: Customers				Sustainable Development Goal																	Comments	
Name	Mkt Cap	% Rev	Relationship Value (\$M)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
VAG	\$ 87,310,000,000	14.00	632.92	0	0	1	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	In 2018, the company undertook more than 500 projects worldwide, including regional structural development, health, education, sport, and environmental conservation.
FMC	\$ 30,340,000,000	14.00	623.70	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	Citing the significant impact of SDGs 3 through 13, the company also weights sustainability initiatives by stakeholder impact.
PGT	\$ 23,570,000,000	12.00	545.65	0	0	0	0	0	1	1	0	1	0	0	1	1	1	1	1	0	0	European leader in the reduction of CO2, largely from the downsizing of gas engines.
RNT	\$ 14,020,000,000	7.65	326.23	0	0	1	1	1	0	1	1	0	0	0	0	0	1	1	0	0	0	Highly focused on a global framework agreement on developing life at work.
GTM	\$ 48,540,000,000	5.00	206.70	0	0	1	1	1	0	1	1	1	0	1	1	1	0	1	0	1	1	Rates initiatives by impact in sustainable development. Leader in gender equality.
DAG	\$ 56,880,000,000	5.00	204.08	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	Provides information on review and implementation of programs. Mentions SDGs in report, but doesn't directly relate initiatives to them.
WMB	\$ 44,970,000,000	4.00	182.50	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	Emphasis on which SDGs are impacted by each initiative. Rates by relevance to internal and external stakeholders.
FNV	\$ 42,040,000,000	3.79	161.81	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	Report lists broad approach to advancing each SDG.
NMC	\$ 24,070,000,000	2.40	102.34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	No information available.
TML	\$ 6,870,000,000	1.79	76.28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Rates initiatives by impact and stakeholder importance.
CUI	\$ 23,970,000,000	0.93	39.63	1	0	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	Emphasis on targets to develop infrastructure including in developing countries through enhanced support to African nations.
VAB	\$ 29,010,000,000	0.68	22.21	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	Hands-on and product-centric approach.
PCR	\$ 23,690,000,000	0.43	18.41	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	No mention of SDGs in report, but impacts them through various programs.
NVR	\$ 2,840,000,000	0.16	6.83	0	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1	

One unique reporting methodology of note was the materiality diagram, used by FMC, GTM, FNV, and CUI. These diagrams plot sustainability initiatives, not SDGs, with influence on the company itself on the x-axis, and influence on external stakeholders

on the y-axis. An example of a materiality diagram may be seen in Figure 3. Because the descriptions used in these diagrams varied widely from broad to more detailed without obvious overlap, actionable conclusions were beyond the scope of this study.

Figure 3

FNV Materiality Diagram (Anonymous Company Report, 2019)



In breaking down the data, customers most uniformly included SDG 7: Affordable and Clean Energy, SDG 9: Industry, Innovation, and

Infrastructure and SDG 13: Climate Action, with 10 out of the 14 companies identifying each of these initiatives (Table 5).

Table 5

Top SDGs by Customer Inclusion

SDG	Description	Inclusion
7	Affordable and Clean Energy	71%
9	Industry, Innovation and Infrastructure	71%
13	Climate Action	71%

The customers, on average, reported activity in 8 out of the 17 total SDGs. Though exactly which SDG varied as explained above, one item of note is that FMC, GTM, and FNV all reported activity in 11 out of the 17 SDGs, indicating participation over a broad spectrum. VAG reported significant activity in 6 SDGs, however, their reporting was less detailed and so their actions were more difficult to classify.

COMPETITORS

We considered competitors to be either true competitors of CMF or other direct suppliers

to OEMs, and used market capitalization as an indication of company size. Our research found that many competitors focused on sustainable development goals. Some privately held companies did not have SDGs or other sustainability initiatives mentioned in their publicly available documents, and so it was not possible to make a determination on their participation in the SDGs. A total of nine main customers were analyzed in this report (Table 6).

Table 6

Competitors data presentation and SDG analysis

Role: Competitors		UN Sustainable Development Goal																	Comments
Name	Mkt Cap	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
BWR	\$ 8,275,000,000	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	BWR has a complete sustainability report on their website
DSO	\$ 34,550,000,000	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DSO has significant information in their website including an environmental and social responsibility report
MGN	\$ 16,580,000,000	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	Some information shown on website, but no formal report
ASE	\$ 8,882,000,000	0	0	1	1	1	0	0	0	1	0	0	1	1	1	1	0	1	Environmental and social section of annual report
TNC	\$ 732,990,000	0	0	1	0	1	1	0	1	0	1	0	1	1	1	1	0	0	SDG Information available on website
CTN	\$ 2,820,000,000	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	Report on website with respect to human rights
VLO	\$ 8,509,000,000	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Heavy emphasis on sustainability on website
EBP	Privately Owned	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	Attention to sustainability throughout product lifecycle. All planning processes start with environmental guidelines.
NF	--	-	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No information publicly available on NF

The top three SDGs emphasized by CMF's main competitors are illustrated in Table 7. It should be noted that SDG 2: Zero Hunger, was not addressed

by any competitors. Only one competitor mentioned SDG 1: No Poverty, perhaps this does not align with the mission set of this group.

Table 7

Top SDGs by Competitor Inclusion

SDG	Description	Inclusion
13	Climate Action	88%
12	Responsible Consumption and Reduction	77%
6	Clean Water and Sanitation	66%

The top participants with regards to SDGs include BWR, DSO, and VLO, all with initiatives impacting at least 14 of the SDGs. Some websites included a sustainability report. Others, such as ASE, for example, appear to have corporate goals and environmental policies that align with the SDGs but are not labeled as such.

Through our business activities designed to ensure coexistence with society and nature, we are contributing to the management of climate change, protection of the ecosystem and resources of the land and sea, and the creation of a sustainable society in which people live in harmony with the environment well into the future. (Anonymous Company report, 2019)

ASE also has a section on social and environmental initiatives in their annual report, which was examined to find efforts corresponding to the SDGs. This examination yielded actions positively impacting nine of the SDGs, evidencing a strong understanding of the value of sustainable initiatives even amongst those competitors not explicitly committing to the SDGs. To highlight these actions, among the nine total, ASE reported initiatives around two of the top three SDGs within the competitor category. SDG 12, Responsible

Consumption, was evidenced through reductions in the metric of waste per sales, which dropped by over 25% between 2010 and 2019. Further, they note a total of 13 examples of waste reduction and recovery initiatives as part of the report, although they are not all listed. SDG13: Climate Action was similarly highlighted in the report, with specific reduction of CO₂ per sales given (nearly 25% between 2010 and 2019) and many other initiatives leading to these reductions either tabulated or further explained within the report.

DATA ANALYSIS

Value Chain as a Whole: Suppliers, Customers, and Competitors Combined

When taking all the above data and looking at participation in each SDG regardless of the company categorization, the top rankings are mostly as would be expected from the category breakdowns above, with the top 3 being SDG 13 at 70% inclusion, SDG 12 at 68% inclusion, and SDG 7 at 49% inclusion. Looking at the remainder of goals topping the Supplier, Customer and Competitor categories, SDG 3 edged out SDG 9, SDG 11 and SDG 6 in close competition, with these goals being included in between 41% and 46% of investigated companies, as illustrated in Table 8.

Table 8

Ranking of all SDGs by Overall Supply Chain Inclusion

SDG	Description	Inclusion
13	Climate Action	70%
12	Responsible Consumption and Reduction	68%
7	Affordable and Clean Energy	49%
3	Good Health and Well-Being	46%
9	Industry, Innovation and Infrastructure	43%
11	Sustainable Cities and Communities	43%
6	Clean Water and Sanitation	41%
8	Decent Work and Economic Growth	38%
4	Quality Education	35%
5	Gender Equality	35%
15	Life on Land	35%
17	Partnerships for the Goals	32%
10	Reduced Inequalities	32%
14	Life Below Water	27%
1	No Poverty	14%
2	Zero Hunger	11%
16	Peace, Justice and Strong Institutions	11%

This study identified the activities of different companies and how they focus on a given SDG. The weight of each SDG by stakeholder importance was beyond the limitations of this study and is recommended for future investigation. Materiality diagrams as discussed in the ‘Customers’ section of this paper.

With respect to aligning specific goals highlighted throughout the supply chain, SDG 13 Climate Action is the area of highest overlap. Because of the specificity of US-based customer sustainability reporting, these documents may be mined for information and ideas on how to best advance this goal. Examples of initiatives that indicate alignment with CMF’s mission are improving efficiency of products in use, decreasing CO₂ emissions and energy use at plants, and utilizing renewable energy at plants (or participating in renewable energy projects to offset carbon footprint). For ideas in advancing this and other SDGs, FMC has a program for sharing best practices with suppliers - Partnership for a Cleaner Environment - which may provide a significant resource for CMF if it is not yet a participant.

Within SDG 13, there is definite emphasis on carbon neutrality and emissions reductions, particularly in the customer segment. Energy savings at facilities as well as electric vehicle research and development, are initiatives in nearly all customer reporting, with electric vehicle research and development being one of the few spending numbers reported by FMV and GTM. FMV reports an \$11 billion investment over the last five years in its 2018 report, while GTM reports a \$28 million expansion to its Global Technical Center battery lab, a \$300 million plant expansion to build electric vehicles, and \$7.5 million in investments for electric charging stations in Michigan, with further partnership investments in this infrastructure globally.

As we live and work in a world of dwindling resources, reviewing the SDG goals for both CMF’s suppliers and competitors illustrates that a major SDG may not be receiving due attention: SDG 4 is missing from the top three for suppliers, customers and competitors. As we move into an

age of technical skills, innovation and a global economy, we need to look at education globally and acknowledge that life-long learning is the order of the 21st Century. If we agree to the theory that 90% of life learning occurs in the first 5 years of our lives (First Things First, n.d.), to leave any level of education unattended is irresponsible, and particularly a child’s formative educational years. A systemic change is required and beneficial to CMF in the form of future workforce. The generalized failure of education systems to manage successfully preparing generations of children for adulthood has resulted in a mass of people lacking basic literacy and numeracy skills as well as life skills. When unemployment figures are low, these are the people that are in the job pool.

Manufacturers are frustrated at the jobs they cannot fill and the skills that are lacking in the workforce pipeline. With the requirement of an increasingly technical work environment to remain competitive and ensure productivity, this must be addressed in the formative years of students’ lives to prevent the problem continuing and escalating even more. Quality Education has obvious impacts to the SDGs well beyond SDG4. The strength of a country’s economy and its safety is related to the quality of the communities. We need to build skills in people to drive positive engagement in their communities. A lack of education and basic literacy and numeracy skills can lead to under-employment, unemployment and disengagement which can lead to low self-esteem and insecurity. To thrive we need socially and emotionally stable people and communities. Society as a whole needs to come to the table to address this issue: public and private sectors, educators and agencies. The learning outcomes of our young students set the tone for the skills of our future workforce. It is not sufficient for the private sector to offer internships to attract employees without addressing the foundational inadequacies of low levels of literacy and numeracy and a lack of soft skills to prevent a life-time of “fixing” employees later. If organizations are worried about their future workforce, SDG 4 should be a priority for them. It will drive new technologies and innovation and help to create a stable, productive workforce.

Finally, we want to address the importance of SDG 17 Partnerships for the Goals. Forging partnerships with aligned organizations can create resource extensions for CMF that can amplify SDG impact. Enhanced cooperation between the private sector, public sector and non-profits can increase the impact of all SDGs. Many times programs, projects and best practices are not shared between organizations that have similar goals and intentions. There can be an impact on the greater community and globe by sharing resources rather than recreating the wheel. In order to increase the impact and expedite the implementation of SDGs, community, regional and global partnerships are essential. If these development goals are to succeed in establishing a global trading system with a commitment to “good governance”, ongoing development for all and a reduction in poverty, there is increased likelihood of success if everyone has shared input, resources and potential solutions.

As focus around the SDGs emerge, long-term planning and resource allocation are critical. Initial capital costs are obvious; however, maintenance and replacement costs can often deter advancement, and even existence of sustainability programs. Initiatives, like goals, greatly benefit from detailed plans projecting decades into the future to ensure continuity and maximize impact. Of the companies studied, while many projected long-term goals, financial data with respect to specific initiatives and goals was sporadic. Of those that had significant statements with respect to spending, the majority were backwards-looking. For example, with respect to SDG 13, Cummins mentioned a \$15 million investment in energy efficiency and onsite solar photovoltaic capital projects, producing \$5.2 million annually in savings. Photovoltaic cells often require periodic cleaning and other maintenance, which in the past would’ve been the responsibility of the electric utility. While it is likely that increased operations and maintenance costs were factored into these particular numbers, it serves as a reminder that they should always be factored into any lifecycle cost/benefit analysis as well as budgeting.

Much of the analysis completed in formulating these recommendations was quantitative, and, as a next step, refinement of the process is recommended. Specifically, a materiality diagram, built around CMF to delineate sustainability initiatives by stakeholder impact would allow investigation to move beyond simple inclusion/exclusion, as weight could be placed on higher impact initiatives.

To remove subjectivity from the review of each company’s reporting, keywords or initiatives should be attributed to each SDG, based on CMF’s own interpretation. This moves reliance away from other companies’ variable definitions to produce more uniform results. The subsequent weighted matrix would yield a result that is specifically tailored to create actions around issues central to CMF’s stakeholders, while still considering supply chain alignment.

CONCLUSION

The results of this research drove the previously mentioned recommendations on which of the SDGs should be included for CMF. In addition to the SDGs recommended for focus in the Data Analysis section, an additional segment of alignment deserves discussion. Despite Industry 4.0, or the Fourth Industrial Revolution, being a popular diction for the last few years when discussing the need to drive change in the manufacturing and logistics industries, Industry, Innovation and Infrastructure was ranked 5th. The goal of Industry 4.0 is to balance operations and processes, increasing productivity, within an ecologically safe environment, using innovative technologies like automation, robotics, artificial intelligence, lean manufacturing, and the internet of things (IoT). Investment has been made in elaborate warehousing systems, even larger containers, computerized coding, block chain, big data, and GPSs to locate any product or part in time and space, predict orders and deliveries as well as locate product failures and recalls within the supply chain tiers.

The data for this research was collected pre-pandemic (2019), one of the largest, and ostensibly

detrimental disruptions to the supply chain globally in years. There were many changes as a result that could impact sustainability initiatives and appreciably impact findings. Just one example is that, despite technological advancements, the pandemic highlighted flaws in outsourcing and the focus on Lean and Just in Time Manufacturing. Companies were sorely compromised by insufficient stock, the diminished workforce, increased security and sanitation measures, backlogs of orders, and greater demands on specific raw materials or parts. Some suppliers, small but critical players in the supply chain, became unable to meet both new and growing demands and went out of business. This caused large gaps in the supply chains further compromising the productivity of multiple industries in many different sectors.

Now, more than two years after COVID-induced disruption, despite the visibility and clarity provided by Industry 4.0, the negative impact of the pandemic remains. This is prompting intentional focus and re-evaluation of how manufacturing and supply chains are managed with an even greater focus on sustainability, supply chain resilience and the ability to remain competitive within the confines of rising costs. This new focus for these industries is causing more change leading to what is being termed Industry/Logistics 5.0. Industry/Logistics 5.0 focuses on sustainability, resilience, and the human factor (Joshi, 2022). How can the blend of technology and people minimize the detrimental impact manufacturing and logistics have on the environment while remaining profitable and competitive?

If we relate this to the UN SDGs frequently mentioned by the suppliers, competitors, and customers, then SDG 13, Climate Action is a key goal. Carbon emissions are an opportunity on multiple levels not just electric vehicles or zero emissions and the use of renewable energy, but also reducing single use plastics. This requires

companies to be intentional when they are designing the products from beginning to end, starting with the finished product in mind. Focus on the initial sourcing of raw materials, end with what happens at the end of the product's life and last mile logistics. Will it be reused, recycled, repurposed? Is it biodegradable or is it going to add to the land fill issues?

Incorporating sustainability data within an organization indicates if they are meeting their SDGs and shows pride in their eco-friendly company and accountability to communities, employees, stakeholders, investors, regulators, industry associations, customers, and suppliers. Adopting tracking devices enables products to be identified and located, which can help further research to refine products and avoid adding to the global pollution and climate problems. The end goal is a circular business model, which can start with reclaimed materials and finish with net zero goals. An example of a company embracing circularity is Colgate-Palmolive. It pledged to use 100 percent recyclable, reusable, or compostable materials for its consumer packaging by 2025 and reduce its use of virgin plastic. Technology enables Colgate-Palmolive to access data up and down its supply chain, which has been integral to the ongoing creation of new, sustainable products (Howells, 2022).

To maximize the impact of the human factor within Industry/Logistics 5.0 surely the importance of SDG 4 Quality Education ranked at 9, as discussed at length previously, is too low. We are happy to report that after our findings from this project were shared with CMF North America in late 2019, the company decided to add in SDG 4 Quality Education. The disruption caused by the pandemic may have validated that decision. It is evident that sustainability is the responsibility of everyone; it requires partnerships, data collection and the sharing of best practices across the supply chain.

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