Manufacturing Digital Transformation Strategy for FMCG

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Summary: This project aimed to close the gap between the technological components of a digital transformation and the human factor. To accomplish this task, several methodologies were applied. On one side, a quantitative analysis based on data obtained from the ERP system of the sponsor company was performed. On the other side, to include the human factor, a survey was administered to discover the digital maturity of the company's bottling plants. Finally, both methodologies were analyzed jointly to provide a holistic analysis of the company that served as a basis for the creation of a Manufacturing Digital Transformation Strategy.

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KEY INSIGHTS

1. **Deciding to initiate a digital transformation requires a long-term commitment from all stakeholders in a company.**
2. **One single Digital Manufacturing strategy usually does not fit all manufacturing plants; therefore, several aligned roadmaps must be developed to adapt the strategy to the idiosyncrasies of the plants.**
3. **A holistic analysis of the company, including the organizational characteristics, the technologies to be implemented, and external factors must be considered in the design of a Manufacturing Digital Transformation Strategy.**

Introduction

Manufacturing companies across all major industries are facing serious challenges to survive and succeed in this ever-changing economy. Even established corporations with long traditions and successful pasts have been losing value because of their incapability to change.

Therefore, leading manufacturing companies are starting to implement initiatives in their plants such as Smart Manufacturing, Industry 4.0, and the factory of the future to create new opportunities to transform, differentiate, and compete.

However, the literature regarding Digital Manufacturing addresses mainly technological aspects of the implementation and not the design of a complete strategy that involves not only **technologies** but also **organization** and **external components** like customers or suppliers.

Our project aimed to close the gap between the technological components of a Digital Transformation and the human factor.

Operational Context

The Fast-Moving Consumer Goods (FMCG) industry is facing great challenges, where corporations are trying to meet customers' changing tastes and demand while keeping their cost structures under control. The sponsor company is a multi-category beverage leader of the FMCG sector, with currently 52 bottling plants across 10 different countries. The company produces a diversified portfolio of beverages: from water to refreshing juices sparkling beverages.

The geographical scatter, together with the idiosyncrasies of each bottling plant, challenge the design and implementation of a unique strategy for Digital Manufacturing.

Methodology

As shown in Figure 1, to combine the information on the performance of the plans and their organizational perspectives, a multiple research methodology approach was used to analyze quantitative and qualitative data from two different sources: BeverageCo's ERP system (scorecard data) and a survey administered to all the plants.

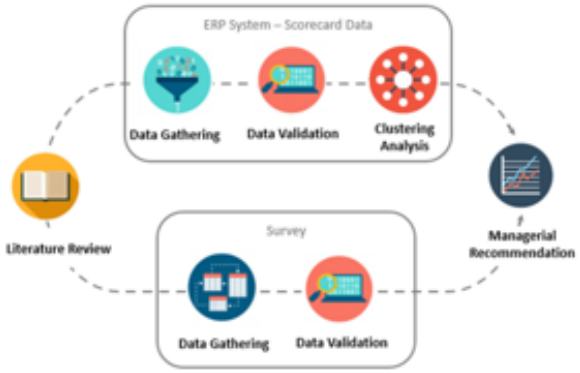


Figure 1 - *Diagram of methodology steps*

Scorecard data: EFA and Cluster Analysis

For scorecard data analysis, an Exploratory Factor Analysis (EFA) was conducted to reduce the number of variables and linear combinations of the original set, and a clustering analysis was performed to define the number of possible groups of plants with similar characteristics according to their performance (Manufacturing KPIs), using hierarchical clustering, and refine the clusters solution through **k-means clustering** algorithm.

Survey: EFA and Multiple Regression Analysis

The survey was designed within the **TOE Framework**. This framework is based on 3 pillars: Technology, Organization, and External Factors. The constructs and the resulting questions incorporated on the survey were based on and adapted from proven constructs found in the literature.

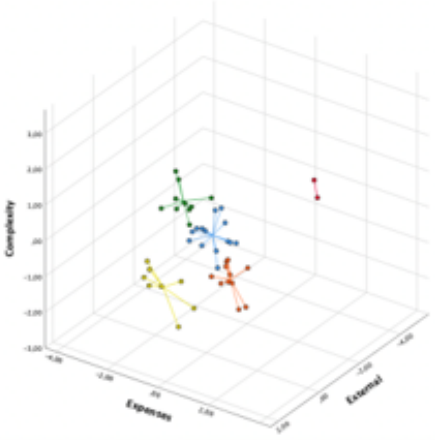
The survey consisted of 3 parts. The first sought information about the location and some personal data about the respondents (e.g. position in the company and number of years working for BeverageCo). The second gave a brief explanation of Digital Manufacturing and asked the respondents about their knowledge and opinions about different technologies commonly associated with Digital Manufacturing. The third part contained questions regarding Digital Manufacturing and was designed to assess the current level of diffusion that these technologies already have. These questions were Likert-scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

With the survey results, an Exploratory Factor Analysis was conducted to validate the applied constructs, Cronbach's alpha analyses were performed for the **validation of the reliability** of constructs, a **multicollinearity analysis** was performed between the dependent constructs, and finally, a **multiple regression analysis** was performed to assess the impact of the independent factors.

Results

Scorecard data: EFA and Cluster Analysis

The original 30 variables from the scorecard data were reduced to 8 KPIs, that were used to perform the EFA. As a result, only 2 factors as a combination of these 8 variables were found relevant: "*Complexity*" and "*Expenses*". Moreover, 2 suitable external variables



Cluster type
1 - Intermediate Complexity and Expenses
2 - Outlier
3 - High Complexity
4 - High Expenses
5 - Low Complexity and Expenses

	Mean (SD) of cluster group					
	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4	CLUSTER 5	F (ANOVA)
Complexity	0.465 (0.302)	0.153 (0.042)	1.199 (0.369)	-0.711 (0.394)	-1.372 (0.528)	64.351*
Expenses	0.401 (0.397)	0.997 (0.469)	-0.669 (0.448)	0.949 (0.48)	-1.419 (0.642)	37.477*
External	0.187 (0.531)	-4.142 (0.47)	0.289 (0.304)	-0.004 (0.478)	0.352 (0.227)	49.689*

*Significant at $p < 0.001$

Figure 2 *– Clusters graphical representation and descriptive analysis*

for all plants were also utilized to create the third factor: "*External*."
Next, hierarchical clustering was used to assess the possible number of clusters. It was found that 5 clusters was the best approach, since dissimilarities between plants could be captured and it made good business sense due to business usability and actionability.
Finally, k-means clustering was performed. The cluster graphical representation and descriptive analysis is summarized in Figure 2.

Cluster 1 was characterized by intermediate levels of complexity and expenses. From the industry point of view, these plants had a good overall performance but they did not possess high levels of automation.
Cluster 2 was composed of only 2 bottling plants that had in common a strong negative correlation with the External factor. This cluster was considered an outlier and was not used in further analyses.
Cluster 3 was characterized by the highest levels of complexity. This group was consistent with the industry perspective because these plants had several production lines and the highest production volumes of the system. Because of this, most of the plants in this cluster were highly automated and have adopted some Industry 4.0 technologies.
Cluster 4 was characterized by the highest levels of expenses. From an industry point of view, this cluster had medium-size plants, with not very profitable SKUs that required special lines to be produced. This cluster had a basic level of automation and moderate overall performance.
Cluster 5 was characterized by the lowest levels, both in complexity and expenses. This group was composed of plants that only produce drinking water and had fewer complex operations. Although the plants were still not automated, these bottling plants were very efficient since they did not have changeovers.

Survey: EFA and Multiple Regression Analysis

We obtained 149 complete responses from a total of 245 surveys sent to the 52 bottling plants, representing a response rate of 61%. The following tests were performed: assessment of possible bias between early and late responses and assessment of potential bias between corporate people and employees working at the bottling plants. The first assessment showed no statistical bias between early and late responses. However, the second test found a statistical difference between the responses from corporate or operational employees.
Next, the EFA and Cronbach's Alpha analysis for all constructs were performed. The constructs "*External factors,*" "*Challenges,*" "*Expected Benefits,*" "*Training,*" "*Culture,*" "*Top Management Support,*" "*Change Management,*" and "*Techno-stress*" were validated. However, the construct "*Competitors*" had a Cronbach's Alpha smaller than 0.7, and thus, it was eliminated from the consequent analysis.
Correlation analysis showed lower correlation coefficients -smaller than 0.7- and a Variance Inflation Factor (VIF) below 5, indicating that the multicollinearity between the constructs could be disregarded.
Finally, regression analysis with the remaining constructs was performed. The model that better represented the framework of the survey was composed of all constructs except "*Culture,*" all contributing to the adoption of technologies.

Conclusions

The main conclusion that can be drawn from the survey is that BeverageCo employees have a fair knowledge of Digital Manufacturing technologies. However, it is important to remark that people working in corporate positions and the people working directly at the bottling plants have a different assessment of the benefits and challenges that a Digital Manufacturing Transformation requires.

Cluster	Strengths	Weaknesses	Strategy	Focus
Cluster 1 - Intermediate Complexity and Expenses	Compatibility Change Management	Techno-stress	Technology	Automation - IoT Big Data Analytics
Cluster 3 - High Complexity	Top Management Support Culture	Compatibility	Technology	Machine Learning Additive Manufacturing
Cluster 4 - High Expenses	External factors	Expected Benefits & Challenges Techno-stress Culture	Organization	Culture
Cluster 5 - Low Complexity and Expenses	Expected Benefits & Challenges Top Management Support Culture	Compatibility	Technology	Sensors for IoT Analytics

Table 1 *– Main characteristics and recommendations per cluster*

Although Digital Manufacturing should be an initiative initially driven by a corporate department, to align all efforts, the understanding of Digital Manufacturing for employees involved in the design and implementation phase should be common.
According to most employees of BeverageCo, the two fields where the company had the most room for improvements are the **adaptability and compatibility of IT systems** to provide a smooth transition to the new technologies and the **change management and training** processes when new processes or technologies are implemented.
For the overall strategy, BeverageCo should work on three main aspects to improve the adoption and effectiveness of the Manufacturing Digital Transformation.

1) To create a framework to train employees in Digital Manufacturing. The **training** should not be based only on digital technologies but also should create a company environment that increases the benefits and goals of the Manufacturing Digital Transformation.
2) To analyze IT infrastructure and physical **integration with legacy systems** already in BeverageCo. The first step is to identify whether the current IT infrastructure and organization could handle the implementation of new technologies. Moreover, if new technologies are to be implemented, it is crucial to determine whether these new technologies could be integrated with the legacy systems already implemented in the bottling plants in order to avoid duplicate or even incompatible systems.
3) To improve the **integration of Supply Chain stakeholders**. Although the Manufacturing Digital Transformation is driven by and implemented in Operations, the initiative must be aligned with the rest of players in the Supply Chain such as Distribution, Procurement and even Sales. A Digital Transformation aims to reduce the silos within a company; thus, other departments should also be integrated into (or at least informed about) the roadmap that Manufacturing creates.

Although the overall strategy should be the same for the whole company, we also provided in Table 1 recommendations per cluster according to the value proposition of each cluster, their current capabilities and performance metrics, and their digital maturity.