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Methodology to define value propositions for manufacturing companies implementing Industry 4.0

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Abstract—The challenges brought by Industry 4.0 are different for each company and world region. Therefore, it is important to develop customized solutions.
This methodology, developed for Mexican companies has the potential to be applied in general scenarios and offers a structured and systematic procedure to facilitate the first steps in the digital transformation journey. It combines concepts used for digital transformation with SIPOC diagram, Six Sigma problem definition, SMART Objectives, value proposition canvas, among others. The outcome is a portfolio of value propositions that shows alignment between the implementation of technologies 4.0 and strategic value generation for the company.

Keywords- Industry 4.0, Digital Transformation, Value Proposition, Problem Description, Project Definition.

I. INTRODUCTION *CHALLENES FOR INDSUTRY 4.0 IN MANUFACTURING COMPANIES)*

Although there is a common agreement on the need for technological progress towards Industry 4.0 and its application in operations and business models, one of the obstacles lies in the perceived complexity and abstraction that partly hinders its rapid practical implementation in the industry [1]. This idea may not be far of reality considering that only 70% of all Digital Transformation Initiatives do not reach their goals [2].

In addition, a study about challenges of Industry 4.0 for Small and Medium-sized Enterprises shows that 40% of SMEs do not have a comprehensive strategy to introduce digital transformation, compared with 20% of large companies. The lack of digital strategy and resources are considered barriers to assess the technological maturity of finding the relevant technological solutions and business uses. The need for a methodical approach to Industry 4.0 implementation was detected [3].

One of the lessons learned to lead organizations succeed on digital transformation is understand your business strategy before invest in technology, rely on the knowledge of the internal staff who have the knowledge about what works and what doesn´t in the organization, aim to customer satisfaction based on their input, manage to change employees fear of being fired to an opportunity to upgrade their expertise for the jobs of the future, and finally to adopt a culture of innovation for agile decision making and with a horizontal structure organization- [2].

In response to these needs, the methodology presented here seeks to facilitate the journey of digital transformation in the organization, both MNEs and SMEs, through identification and description of challenges (problems and opportunities) for value creation along the end-to-end manufacturing process, prioritizing the more promising ones in terms of benefits, and finally proposing an adequate cost-benefit solution with emerging technologies of Industry 4.0.

This methodology consists of 5 structured phases: 1) awareness, 2) value drivers' identification, 3) value proposition 4.0, 4) digital maturity and identification of gaps, 5) portfolio of key projects to solve them. This paper will focus on phases two and three. Each of these phases has a series of standardized supporting documents: a general agenda, interactive presentations, and teamwork dynamics, facilitated with large posters, post-its and collaborative documents in the cloud.

The application of this methodology is done through guided step-by-step workshops, lasting 3 to 5 days. Key functional areas of the organization must be represented, such as human resources, finance, IT, operations, planning, customer service and engineering.

II. VALUE DRIVERS IDENTIFICATION PHASE

In the value driver identification phase, different tools and concepts are applied such as McKinsey Digital compass [4],

SIPOC diagram, RACI matrix [5], and OEE metric [6]. These tools are used to identify challenges for value creation through manufacturing main processes and metric gaps analysis. In addition to the above, this phase also helps to generate buy-in, alignment of objectives, and accountability among the leaders of the different areas of a company.

According to McKinsey, the eight value drivers that impact manufacturing performance are: resource and process, asset utilization, labor, inventories, quality, supply/demand match, time to market, and service after-sales. McKinsey also proposes "Industry 4.0 levers" for each value drivers, which are technology applications that have the potential to lever improvements in business metrics [4]

A diagram is here developed (Fig 1) to understand the value drivers by relate them to the elements of a SIPOC: Supplier, Input, Process, Output, Clients [5]

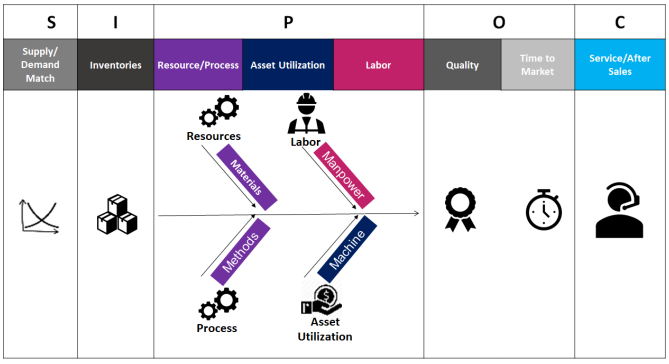

Fig. 1 SIPOC and Fishbone for Value Drivers

A Fishbone diagram is integrated as well, to identify the value drivers directly related with process, such as Labor (Manpower), Resources (Materials), Process (Method) and Asset Utilization (Machine)

In addition, the industry level and industry metrics are included in the diagram to identify which one could be selected depending on the specific problem being faced (Fig. 2).

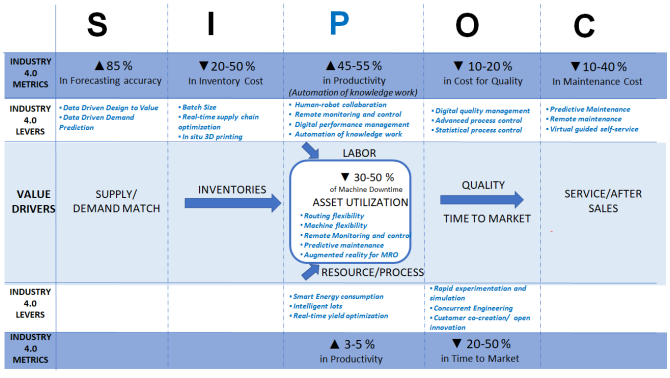

Fig. 2 SIPOC with Value Drivers and Industry Levers

Additional Information for the value driver identification stage is obtained by doing a metric gap analysis using the Overall Equipment Efficiency (OEE) as a metric, which is associated with the creation of value in manufacturing industries around the world [6]. When the manufacturing process is mapped through the SIPOC approach, the impact on OEE metric of different value drivers is visualized, starting with asset utilization, labor, resources and processes, time to market and quality. Although indirectly there are also inventories, and supply/demand match. If leaders want to have an improvement on the OEE metric, they need to reflect at least on these value drivers. This effort will lead them to a new challenge: to work collaboratively within silos of the company.

To tackle the relevant challenges for generating value for the company, the leaders of each area must recognize their accountability and responsibility for one or more value drivers. In SME cases, leaders select some of the most relevant value drivers for the business. The information of who is **R**esponsible, **A**ccountable, must be **C**onsulted with, and shall stay **I**nformed is mapped on a **RACI** matrix [7]

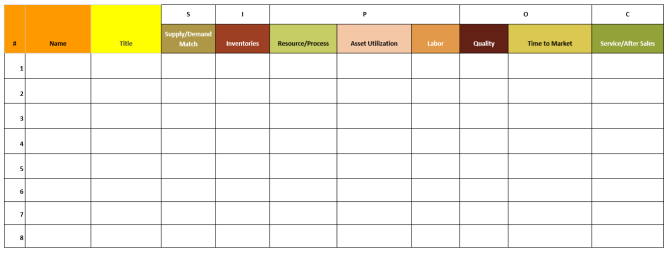

Fig. 3 Value Driver Responsibility Assignment Matrix

III. VALUE PROPOSITION 4.0 PHASE

This phase aims to design a value proposition for the most relevant challenges, prioritized according to their impact on value creation.

The tool here called Value Proposition 4.0 (VP4.0) is an adaptation of the Value Proposition Canvas (VPC) [8]. A value proposition is defined as a description of the benefits that customers can expect from products or services. A VPC is a graphic representation with two parts: A traditional industry profile and a value map for industry 4.0. Within the traditional industry profile (customer profile) value drivers (jobs), Challenges (pains) and value metrics (gains) are identified. In the value map por industry 4.0, it is described how value for this customer segment is created by an Industry Lever (pain reliever) through a solution (product or service) based on a Technology 4.0 with the corresponding deliverables (gain creators) that improves an industry value metric (creates gains) (Fig. 4).

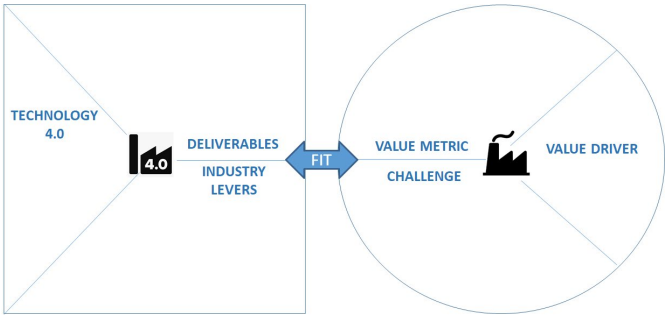

Fig. 4 Value Proposition 4,0 (VP4.0)

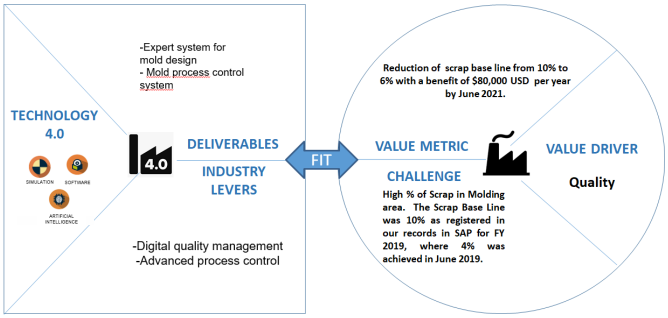

Fig. 5 Value Proposition 4,0 (VP4.0)

For each of the challenges detected during the Value Drivers identification phase, a statement is written to describe and communicate the problem. To establish a clear, concise, and specific problem statement, the following guide questions from Six Sigma problem definition are answered [5].

- What is the problem? (use a negative adjective plus a primary metric).
- Where does the problem occur? (area/ department / team / process).
- When was the problem first observed? (relative to time or specific situation)
- How extensive is the problem? (baseline of primary metric value and source of the data)
- How do we know this is a problem? (entitlement of primary metric, which could be a short-term maximum value, benchmark, regulation, industry standard or company goal)

Then, it is also requested to estimate financial benefits through the declaration of the SMART (Specific, Measurable, Aggressive yet achievable, Relevant, and Time-Bound) objective associated with the problem [5].

- Specific (Verb in infinitive)
- Measurable (metric)
- Aggressive yet achievable (from baseline to target)
- Relevant ($ USD / Year)
- Time- Bound (for MM / YYYY date deadline)

An example of industry profile for a specific challenge is shown in Fig. 5. The value driver selected is Quality and the challenge, problem in this case, is the" high percentage (%) of scrap in the molding area, with line base of 10% as registered in our records in SAP for FY 2019, where 4% was achieved in June 2019"

After identifying the impacted value driver and estimating the benefit, a priority is established to maximize the strategic impact of value for the company.

Value driver (customer job), problem statement (pains), and SMART objectives (gains) describe the "customer profile" of VP4.0.

Then, an exploratory root cause analysis is determined to capture insights for the initial value map. Some tools recommended are 5W and Fishbone Diagram, brainstorming, affinity diagrams, and multi voting techniques.

Industry levers corresponding to the Value Driver identified are selected from Fig. 2. Technologies for Industry 4.0 are selected from Fig. 6.

Fig. 6. Technologies for Industry 4.0

To define the elements of the "value map", industry 4.0 levers are considered "pain relievers", technologies associated with Industry 4.0 are the "product and service" and the business metrics surrounding The Mckinsey Digital Compass corresponding to each industry lever (see Fig 1) are assigned as "gain creators".

The information of the value map is integrated on the Value Proposition 4.0 as shown in Fig 6.

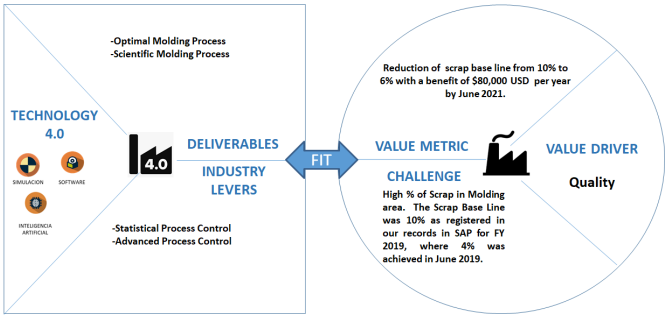

Fig 6. Value Proposition 4.0 for a Quality Value Drive

This tool not only allows to visualize the value proposition but can also be used as a framework to guide its presentation as follows: "to positively impact in a company's relevant value driver, priority problems/challenges are identified, which can be solved by applying industry levers, that are achieved through the implementation of a set of technologies 4.0, whose deliverables generate benefits, which will ultimately impact on the generation of value for the customer."

This VPC 4.0 portfolio provides an input for next phases on the methodology when it is performed an in-situ digital maturity diagnosis, to suggest a cost-effective solution and contact with digital solution providers.

IV. Insights about Methodology Application in Mexican Companies.

The systematic methodology here presented was applied to define value propositions in the context of Industry 4.0 in 9 large and medium-sized and 4 small-sized manufacturing companies in México. The 13 large, medium and small size of companies belong to a broad range of industrial sectors, such as manufacturing of capital goods, providers for the automotive industry and for oil and gas industry. The methodology was applied individually in each one of the 9 large and medium sized companies. In the other hand, the methodology was applied to the 4 small-sized manufacturing companies managing them simultaneously as a group.

A list of relevant value drivers and its related challenge statements were declared. Six challenges were identified on average for company. The 3 most relevant value drivers selected were: Quality, Asset utilization, and Resource/Process. Potential causes were identified to attack these challenges with technologies 4.0 to reach the defined objectives.

In a workshop for 4 small-sized manufacturing companies, an average of 3 challenges by company were identified. The 3 most relevant value drivers selected were Quality, Asset utilization, and Inventories.

Other differences observed were:

- In SMEs, the need to implement lean and six sigma before 4.0 technologies was evident, where tools such as SMED, standard work and basic training are expected to deliver significant improvements
- In Large and Medium Sized companies: scrap generation, low human productivity and inventory optimization were the more relevant causes; productivity challenges are associated with people rather than machines; scrap is as common as rework for quality issues; it is perceived more awareness about the root causes and economic impact of challenges.

These results are not only useful as a guide for organizations that are interested in starting their own digital transformation towards industry 4.0, but also for ecosystems integrated by government, academia, entrepreneurs, and society to align and develop strategies for collaboration, providing each entity the necessary elements to impulse digital transformation.

V. Conclusion

The methodology here presented offers a structured and systematic road map for success on the implementation of industry 4.0 technology, by aligning it with the generation of value for the company, from start to end, reducing the risk of working in projects without expected return of investment.

The integration of methodologies such as SIPOC, OEE, Fishbone, RISC and Value Proposition Canvas, among others, complement and facilitate the comprehension and application of tools such as the Mckinsey Digital Compass.

The successful application in 9 large/medium and 4 small companies demonstrates the potential of this methodology for its use in different sizes of companies.

The insights of the application of this methodology to 13 companies in México, and the different results obtained with large, medium and small sized companies is described, concluding that tools of lean and six sigma methodologies such as SMED and standard work, should be previously applied to solve basic problems and maximize the benefit of implementing industry 4.0 technology.

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