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Abstract. Industry 4.0 leads new digital solutions to optimize the entire value stream in the whole manufacturing production systems. Current production systems are often based on the continuous improvement approach of lean management. New opportunities arise by implementing Industry 4.0. The digital transformation towards smart connected factories causes enormous changes in mechanical engineering industry starting from the development of cyber physical systems up to their application in the whole production systems. This paper aims to present the current manufacture state of food and beverage manufactures and the framework to implement digital transformation towards Industry 4.0. Technology Organizational Environment (TOE) method is used. Then Analytical Network Process (ANP) is introduced to reflect the correlation among criteria based on readiness perspective. Finally VIKOR is employed to rank the options on the basis of expert subjective preferences.

1. Introduction
As the new trends, challenges and requirements for today food and beverage manufactures, new findings and insights from research and industry request an upgrade or a modification in the existing manufacture systems. In today’s competitive business environment, customers increasingly strive for maximization of personalized value which becomes particularly obvious in the demand for individualized products and also the increasing influence of customers on the development and the production processes. Many suggest that manufacturers can only meet this challenge by implementing Industry 4.0 in their organization. Industry 4.0 represents the aspired target state through improvements in information, communication and automation technology live information is available over life cycles of products, processes and factories [1]. Production systems, products and human are closely networked. Moreover the resulting big data is used for optimization the whole systems. Based on customer’s data, there are numerous new possibilities for product and process improvements including the optimization of the machining process or spare part forecasting services. At the same time, they are confronted with new demands. With this, a close collaboration of manufacturers and mechanical engineering enterprise is required. Through this transformation, IT is not serving as just a technological tool to improve the efficiency of internal process. By becoming an essential part of the value creation, it grows up to a new source of competitive advantage and thus take a transformative role. Besides mechanics and electronics, manufacturers need to develop digital capabilities and implement them into fast-changing, cross company processes and structures; especially for manufacturer in Indonesia this is an enormous challenge.
With the help of business model approaches, many manufacturers already started to plan digital values creation concepts. However, these are very limited when it comes to deriving and implementing processes and IT services. In contrast to existing IT-based products, the new service logic requires a holistic process view. To get full advantage of the digital opportunities adequate model, methods and tools are needed. With enterprise architectures information systems literature already offers a well proven solution for this challenge. The aim of this paper is to examine the current state of food and beverage manufactures in Indonesia and then develop a conceptual model needed for digital transformation or implementation of Industry 4.0 in food and beverage manufactures.

2. Literature Review

2.1. Industry 4.0
The first three industrial revolutions were all about mechanization, electricity and information technology (IT) to human manufacturing. The passive machine and robots have replaced the labors forces, meaning they are controlled by human without consciousness. On the other hand, many still believe that this technology is still expensive in its use of employees and additional resources required for controlling, checking, or efficient maintenance. Recently, benefitting from Internet of Things (IoT) and Cyber Physical System (CPS) the industry relevant items are able to connect, meaning these necessary objects are going to exchange information and control actions with each other independently and autonomously. In other words, products tend to control their own manufacturing process.

2.2. Technologies used in Industry 4.0
There are a lot of technologies for implementing Industry 4.0, such as Big Data Analytics (BDA), industrial internet of things or known as a concept which aims to add the benefits of internet connectivity as continuously connected [2], cyber physical systems, cyber security, cloud computing, additives manufacturing, augmented reality, machine learning etc. [3]. In order to implement Industry 4.0, many companies adopt these technologies in their production system. BDA tools help analyses real data to enhance productivity and reduce the uncertainty in decision making process [4]. This tool helps various companies including food and beverage manufacturer to make supply chain more efficient and sustainable.

Nowadays, businesses are largely depending on real-time data analysis and data storage facility. In Industry 4.0, cloud computing helps to storage such real time massive data which is collected from various sources for industrial manufacturing purposes [3]. It helps to link and share communication devices from one company to the other to facilitate the manufacturing plant [3]. The concept of digital production can be achieved via cloud computing based connection among companies from each country to the other [3].

Additive Manufacturing (AM) based technologies are those used to make faster and cheaper the production system [5]. AM helps manufacturing companies to produces small amount of customized products with design optimization [3]. AM also can help to reduce the transport distances and stock on hand [6]. Customers demand is changing day by day and AM helps to fulfil the demand of customers by continuously changing the design of products. Augmented Reality is a service system which helps to support the industry via communication device. It helps industry to collect real time data from customers [6]. Machine learning is a dynamic computer based techniques that can extract useful information and best decision from big data, the massive data, both structured and unstructured, which can be achieved from a business at a given time [3]. Machine learning has a sufficient impact in the manufacturing system to monitor the defect, detection of faults, and predicting of future needs [7].
3. Methodology

3.1. Research Design

Assessing the readiness for implementing Industry 4.0 is a multicriteria decision analysis problem. This research investigated the current production state in the context of food and beverage industry in Indonesia. Several key factors for implementing Industry 4.0 were identified based on combination of literature review and Industrial managers’ feedback [3]. These managers include experts in operations management. The evaluated key factors were evaluated via Technology-Organization-Environment (TOE) framework.

3.2. Technology-Organization-Environment (TOE)

Tornatzky and Fleicher developed TOE framework to present dimensions of enterprise’s context that affect the adoption and implementation of new innovations or technology [8]. The contextual dimensions include technological, organizational and environmental contexts [8]. Technological context focuses on how technological practices and structures can influence the whole adoption process [8]. The organizational context manifests common organizational attributes that may facilitate or constrain technology adoption [8]. The environment context reflects the firm surrounded by multiple stakeholders such as competitor, suppliers, customers, the community as well as government. All the factors which will be consider in TOE are based on literature review results as seen in figure 1.

3.3. ANP and VIKOR

The identification of critical components of a system is a multi-criteria decision making problem since it involves various criteria and sub-criteria [9]. ANP method is used for establishing outer dependencies, i.e., relations between the factors belonging to different groups, as well as to determine the final weights of the criteria [10]. ANP method allow assessing the consistency of the judgments and facilitates the process of assigning weights by splitting up the problem into smaller parts, appropriate for more detailed analysis [10]. However, the ANP method can be problematic in terms of presentation of interdependence between criteria and alternatives. Therefore, VIKOR method is used in the second part of the model for ranking the alternatives and selecting the best one [10].

![Figure 1. The technology – organization – environment (TOE) framework](image-url)
4. Results and Discussion

4.1. Data Collection

The data are collected by interviewing 5 experts from food and beverage manufacturer. All the questions are based on literature review on which factors will be critical for implementing Industry 4.0. The questionnaire are construct based on TOE grouping.

- **Technology Context**
  Many believe than, a firm with higher quality human resources, better educated employee will have greater capability in technological innovation. This technological innovation can only be achieved if it is supported by proper technology infrastructure.

- **Organizational Context**
  Commonly, larger firms’ size will have more advantages over smaller one, as they have more resources as well as financial to support new technology adaption.

- **Environment Context**
  The environment consists of government policy, competitor pressure as well as legal issues. Most of the cases, pressure from competitor is act as external power pressing a firm to adopt new technology.

Below questionnaire are distributed to 5 experts from several food and beverage manufacturers in Indonesia (table 1). The questionnaire are given as Likert scale questionnaire.

**Table 1.** List of construct for experts’ assessment.

| Group            | Construct Name                  | Questions                                                                 | Items Code |
|------------------|---------------------------------|---------------------------------------------------------------------------|------------|
| Technologies     | IT Infrastructure (IT)          | Company already has planned to build IT infrastructure which support the implementation of Industry 4.0 | IT1        |
|                  |                                 | Current IT infrastructures are applicable to be upgraded to Industry 4.0   | IT2        |
|                  |                                 | Physical integration of Industry 4.0 will not cause trouble to company   | IT3        |
|                  |                                 | The company can integrate the software needed for Industry 4.0 with only a little effort for existing IT landscape | IT4        |
|                  |                                 | Overall, the dimensions of the technology context are a measure of readiness for implementing Industry 4.0 | IT5        |
| Organization     | Management Support (MS)         | Top Management has an open view of change                                  | MS1        |
|                  |                                 | The vision and mission of the company must be in line with the company's plans to implement Industry 4.0  | MS2        |
|                  |                                 | The concept of Industry 4.0 must be in accordance with the culture and identity of the company | MS3        |
|                  |                                 | Top Management has a strong commitment to bear all possible losses that occur during the process of implementing the Industry 4.0 concept | MS4        |
|                  |                                 | Top Management allocates facilities and infrastructure for implementing the concept of Industry 4.0 | MS5        |
|                  |                                 | The company has the financial ability to implement Industry 4.0           | F1         |
The company is committed to invest in the implementation of Industry 4.0  

The company has sought comprehensive information about the concept of Industry 4.0 (advantages and disadvantages)  

The company has received comprehensive information about the concept of Industry 4.0 (advantages and disadvantages)  

The company has a paradigm that Industry 4.0 is the solution needed by the company  

Employees have an open view of change  

Employees have an openness to implement change  

Employee skills are in accordance with the criteria needed to implement the concept of Industry 4.0  

Employee skill values have met the value of the criteria needed to implement the concept of Industry 4.0  

The company has understood the need to implement Industry 4.0  

The company has benchmarked to implement Industry 4.0  

Overall the dimensions of the organizational context are a benchmark of readiness for implementing Industry 4.0  

The company already knows about legal issues related to implementing Industry 4.0  

The company has designed solutions needed to deal with legal issues related to implementing Industry 4.0  

The company has received comprehensive information on the issue of cyber security  

Companies already have action plans to prevent cyber crime  

The company already has an action plan to address the occurrence of cyber crime  

The company has conducted an analysis of competitors who have implemented the concept of Industry 4.0  

The company has designed a solution or action that is the company’s superiority regarding the implementation of Industry 4.0

| Information Availability (IA) | F2 | IA1 | IA2 | IA3 |
|-------------------------------|----|-----|-----|-----|
| Employee (E) | E1 | E2 | E3 | E4 |
| Benchmark (B) | B1 | B2 | B3 | L1 | L2 |
| Legal (L) | CS1 | CS2 | CS3 | C1 | C2 |

Experts’ assessments results are shown in Table 2 below. 1 means the expert is very disagree with the factor, 2 means disagree, 3 means doubtful, 4 means agree while 5 means the expert is very agree with the factor.
4.2. Data Analysis

The questionnaire results were evaluated for reliability, convergent validity and discriminant validity. Construct reliability or also known as internal consistency was assessed by computing Cronbach alpha [11]. As shown in Table 3, Cronbach alpha was found to be ranging from 0.762 to 0.834. In many research, a reliability coefficient of 0.7 or higher is considered acceptable. The analysis results show that the data is considered to have relatively high internal consistency.

| Variable | Mean | Variance | Correlation | R²  | Cronbach’s alpha | Guttman L6 |
|----------|------|----------|-------------|-----|------------------|------------|
| IT1      | 64.2 | 46.7     | 0.569       | 1   | 0.777            | 1.00       |
| IT2      | 63.4 | 50.8     | 0.267       | 1   | 0.792            | 1.00       |
| IT3      | 63.6 | 58.3     | -0.469      | 1   | 0.834            | 1.00       |
| IT4      | 63   | 55       | -0.377      | 1   | 0.811            | 1.00       |
| IT5      | 64.6 | 49.8     | 0.336       | 1   | 0.789            | 1.00       |
| MS1      | 64.4 | 50.3     | 0.143       | 1   | 0.8              | 1.00       |
| MS2      | 64.6 | 50.3     | 0.27        | 1   | 0.792            | 1.00       |
| MS3      | 64.6 | 52.8     | -0.05       | 1   | 0.803            | 1.00       |
| MS4      | 63.8 | 41.2     | 0.697       | 1   | 0.763            | 1.00       |
| MS5      | 64.6 | 52.8     | -0.05       | 1   | 0.803            | 1.00       |
| F1       | 64.6 | 52.8     | -0.05       | 1   | 0.803            | 1.00       |
| F2       | 64.6 | 50.3     | 0.27        | 1   | 0.792            | 1.00       |
| IA1      | 64.4 | 43.3     | 0.79        | 1   | 0.762            | 1.00       |
| IA2      | 63.6 | 47.3     | 0.677       | 1   | 0.776            | 1.00       |
| IA3      | 64.4 | 49.3     | 0.51        | 1   | 0.785            | 1.00       |
| E1       | 63.8 | 46.7     | 0.761       | 1   | 0.773            | 1.00       |
| E2       | 63.8 | 46.7     | 0.761       | 1   | 0.773            | 1.00       |
| E3       | 63.8 | 49.2     | 0.416       | 1   | 0.786            | 1.00       |
| E4       | 63.6 | 49.8     | 0.336       | 1   | 0.789            | 1.00       |
| B1       | 63.8 | 50.7     | 0.218       | 1   | 0.794            | 1.00       |
| B2       | 63.6 | 49.8     | 0.336       | 1   | 0.789            | 1.00       |
| B3       | 63.8 | 56.2     | -0.463      | 1   | 0.817            | 1.00       |
| L1       | 63.6 | 47.3     | 0.677       | 1   | 0.776            | 1.00       |
| L2       | 63.6 | 47.3     | 0.677       | 1   | 0.776            | 1.00       |
| CS1      | 63.6 | 48.8     | 0.248       | 1   | 0.795            | 1.00       |
| CS2      | 63.4 | 48.3     | 0.318       | 1   | 0.79              | 1.00       |
| CS3      | 63.4 | 48.3     | 0.318       | 1   | 0.79              | 1.00       |
| C1       | 63.6 | 47.3     | 0.677       | 1   | 0.776            | 1.00       |
| C2       | 63.8 | 47.7     | 0.621       | 1   | 0.778            | 1.00       |
4.2.1. **Technology context.** The reliability analysis shown that technological context strongly affect the readiness for implementing Industry 4.0. Manufacturers with high technological readiness are aware of current IT infrastructure potential and limitations and willing to provide necessary training for implementing Industry 4.0. In other words manufacturers who have technological readiness are on better stage for implementation of Industry 4.0.

4.2.2. **Organizational context.** Organizational relates to several different factors concerning the manufacturer itself, including management support, financial capabilities as well as the employee itself. Top management support is very important for manufacturer looking to create a competitive environment whilst also providing the qualified resources required for implementing Industry 4.0. Top management has to recognize the potential benefits of implementing Industry 4.0.

4.2.3. **Environmental context.** Environmental context covers the area that a manufacturer conducts its business including the competitors, legal issues, as well as security factors affecting their business. Pressure from competitors are highlighted as a strong adaption driver. Through implementation of Industry 4.0, manufacturers can benefit from better operational efficiencies, and might be able to reduced cost that will bring manufacturers higher profits.

5. **Conclusions**

This very first part of the research has led to the main factors which need to be ready towards implementation of Industry 4.0 technologies which were obtained from literature review. These results represent a general perspective of company wishing to begin the implementation of Industry 4.0. Starting from assessing the current status of Company using TOE framework. Afterward the experts were interviewed based on these factors. First results shown that the factors used in this research are very reliable. The conclusions of both literature study as well as field study through interviews are showing that Industry 4.0 is one of the key leverage to maintain competitiveness of food and beverage manufacturer in Indonesia. But, the implementation type depends on many factors and different for each organization.

The organization which was assessed shown that in terms of technology, organization and environment they are in maturity stage, which mean the application for implementation process is limited to certain tasks. It needs to be analyze in more details what would be the very first step to upgrade their current manufacturing stage.

Furthermore, the factors mentioned above need to be analyse in more details with ANP as well VIKOR to get a better understanding and more precise conclusion on readiness of food and beverage manufacturer in Indonesia to implement Industry 4.0.

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