IDEF0 Modeling Standard: A Tool for Process Map Drawing under Requirements of ISO 9001: 2015: A Case Study

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Abstract
In the two past decades, powerful and highly user-friendly software has been introduced to modeling organizational processes. With some of this software, you can easily draw the sequences of business activities and processes in different organizations and industries to visualize the organization as a whole. On the other hand, the emphasis on the process approach at ISO 9001: 2000, and in particular at ISO 9001: 2015, has made process map extraction as an important issue for organizations. One of the best tools for the extraction of process maps is the IDEF0 standard, which allows you to extract organizational processes maps in fine detail, thereby displaying organizational processes as a whole. iGraf IDEF0 is one of the best software for modeling processes according to the IDEF standard. This article will describe how to extract the organizational process map in a production engineering company to implement ISO9001: 2015. Extracting these process maps plays a key role in institutionalizing the process approach in people.

Keywords
IDEF, ISO 9001: 2015, Process Approach, Process Map

1. Introduction

Today, organizations are increasingly focusing on flexibility, improvement, and procedures there appears to be a need to evaluate current approaches to the implementation of the ISO 9000 requirements. The ISO 9000 series is an international standard that can be used by organizations to develop and document their quality management systems. An effective quality management system allows a business to ensure that its products and services consistently adapt to customers 'requirements [1]. Numerous researchers pointed out, process management helps to reduce costs, improve the efficiency of processes in the organization and increase productivity by improving communication and structure of manufacturing systems [2, 3]. ISO 9001: 2015 more focuses on process management. To manage the processes in the organization, managers need to institutionalize the process approach in the organization. One of the ways to create a comprehensive mental image of organizational processes is to draw these processes by using appropriate software and related standards. One of the best standards for defining processes is the IDEF standard, and one of the best software to extract process maps according to the IDEF standard is the iGraf IDEF0 software. The IDEF0 technique is a powerful analysis tool that describes company environments through activities and concepts [4]. The IDEF0 is used to business processes mapping in different manufacturing engineering organizations. [5, 6, 7, 8].

2. Literature Review

2.1 ISO 9001 and Process approach

All the requirements of ISO 9001:2015 are related to one or more principles. These principles provide the reasons for the requirements and are thus very important [9]. ISO 9001 is related to business processes and specifies the requirements for a quality system. In the 2015 revision, the systems approach principle was removed and the process approach principle revised to include the phrase "interrelated processes that function as a coherent system" [9]. Pre-2015 versions were more widely used in manufacturing companies, But ISO 9001: 2015 applies to both manufacturing and service providers companies. In section 4.4 (Quality Management System and its Processes), in ISO 9001: 2015 the process requirements are as follows:

- 4.4 Q1: The organization shall establish, implement, maintain and continually improve a quality management system, including the processes needed and their interactions, under the requirements of this International Standard.
- 4.4 Q2: The organization shall maintain documented information to the extent necessary to support the operation of processes and retain documented information to the extent necessary to have confidence that the processes are being carried out as planned.
- 4.4 Q3: The organization shall determine the processes needed for the quality management system and their application throughout the organization and shall determine:
  - The inputs required and the outputs expected from these processes;
  - The sequence and interaction of these processes;
  - The criteria, methods, including measurements and related performance indicators needed to ensure the effective operation, and control of these processes;
  - The resources needed and ensure their availability;
  - The assignment of the responsibilities and authorities for these processes;
  - The risks and opportunities under the requirements of 6.1, and plan and implement the appropriate actions to address them;
  - The methods for monitoring, measuring, as appropriate, and evaluation of processes and, if needed, the changes to processes to ensure that they achieve intended results;
  - Opportunities for improvement of the processes and the quality management system [10].

What is the process approach?

All organizations use processes to achieve their objectives. A process is a set of interrelated or interacting activities that use inputs to deliver an intended output [11]. The process approach is expressed in ISO 9001: 2015 as follows: Consistent and predictable results are achieved more effectively and efficiently when activities are understood and managed as interrelated processes that function as a coherent system [9]. The process approach was first introduced in ISO 9001: 2000, but its requirements in the latest standard version(ISO 9001: 2015), have become clearer and less ambiguous. The process approach had a significant impact on the way requirements were expressed.

2.2 Process Documentation

Today, documentation is one of the main needs of industrial, commercial and public organizations [12]. Documentation is a useful and effective way to identify, document and control activities and processes that affect the quality of goods or services in any organization [13]. The scope of application of documentation covers all information, standards, records, and documents of organizations. This is especially true for processes and is essential in any industry organization, especially large and medium-sized organizations. In any organization for documenting records, a specific structure and method must be defined. This structure can be unique or several organizations follow the same structure and model. The ISO 9000 family standards, and IDEF0, outline the minimum procedures and requirements for documenting systems, processes, records, and other organizational events [12].

2.3 IDEF0 Standard

IDEF0 or " Integrated Definition for Function Modeling "is a standard established by the US Air Force in 1981 as a standard and common methodology for providing uniform and well-defined models to display the relationship between activities, functions, and tasks [12, 14, 15, 16]. IDEF0 is one of the best tools for functional modeling [1]. In its original form, IDEF0 includes both a definition of a graphical modeling language (syntax and semantics) and a description of a comprehensive methodology for developing models. The specification of this standard is to consider the relationship between underlying processes and sub-processes, identify relationships of activities, and provide a holistic view of all processes within a system [12, 14]. IDEF0 is a tool for the design of the model of decisions, actions, and activity of an organization or system [17, 18]. IDEF0 functional modeling is a hierarchical functional decomposition, consisting of five elements. In the IDEF0 functional model, the activity (or process) is represented by boxes. Arrows on the diagrams are called ICOM, which stand for:

I: Input (on the left), something used in an activity, for example, material;

C: Control (on the top), controls or conditions activities, for example, the standard of education;

O:Output (on the right), activity result, for example, product or services and

M: Mechanism (on the bottom), for example, employees who perform that activity [12, 14, 15]. As mentioned above the IDEF0 is a set of activities that takes certain inputs and, utilizing some mechanism, and subject to certain controls transform the inputs into outputs[19].

In the two past decades, powerful and highly user-friendly software has been introduced to modeling organizational processes. With some of this software, you can easily draw the sequences of business activities and processes in different organizations and industries to visualize the organization as a whole. Figure 1 shows how the five process factors are placed in the iGraf IDEF0 software.

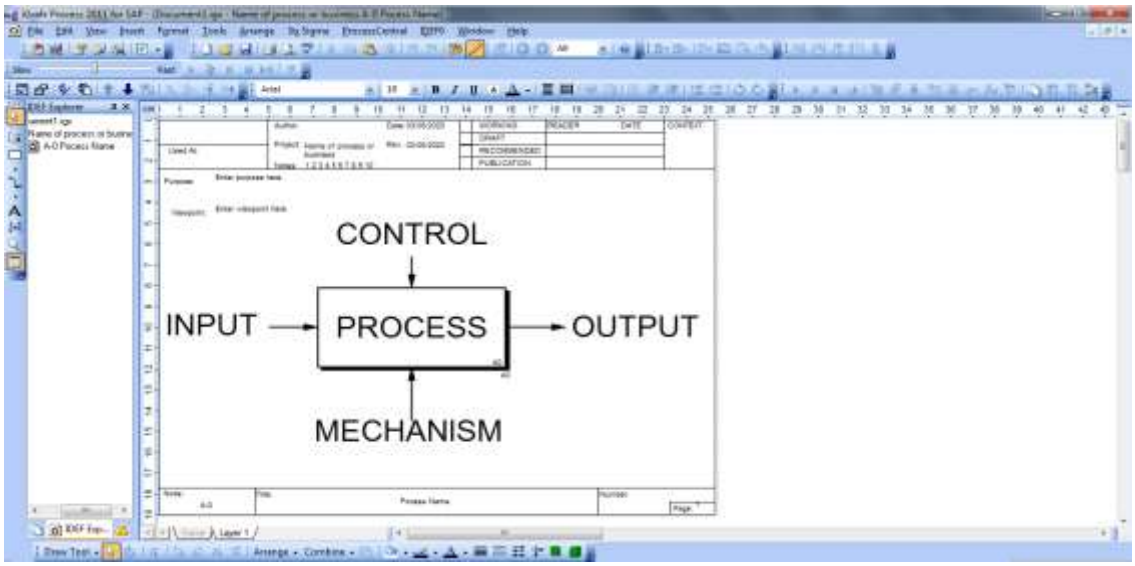

Figure1. IDEF0 process model Representationin iGRAF software

The characteristic of the IDEF0 modeling technique is that each activity and the ICOM's can be decomposed in more detailed levels of analysis (Figure 2) [20].

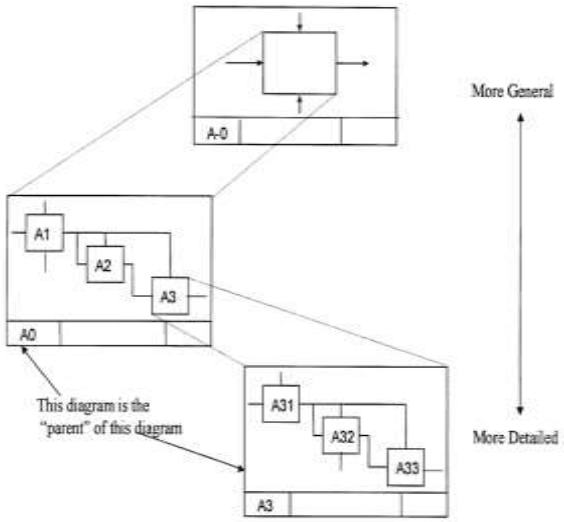

Figure 2. Decomposition construction of an IDEF0 model

A single process represented in the top-level context diagram may be decomposed into its major sub-process by creating its child diagram. In IDEF0 software if the process has a shadow, it means that it has several sub-processes or activities that can be clicked on and observed its processes/sub-activities. In turn, each of these sub-functions may be decomposed. We can move to higher processes by clicking on the parent arrow. So a chart may contain a parent chart (including parent boxes) and a child chart (details of their parent box). Therefore, the process map can be easily extracted with this software. The hierarchical nature of IDEF0 allows the system to easily extract more details and make it useful for decision making.

Additional IDEF techniques were developed for information analysis (IDEF1), dynamic analysis (IDEF1x), and process modeling (IDEF3) [3, 21, 22]. Among the different IDEF techniques may the IDEF0 be the most widely used version in manufacturing process analysis [23].

3. Research Methodology

To carry out this research, specialized texts related to ISO 9001: 2015 and numerous articles on IDEF0 and process approach were downloaded from sciencedirect.com and the subject literature was thoroughly studied and analyzed. Then the concepts of the process approach were fully explained in a workshop for Kanya Noor Barzin Zagros Company (LED lamp manufacturer) managers. Next, by conducting specialized meetings with process owners, the details of the company processes were extracted and all necessary documentation for process optimization was compiled and process maps were drawn by using iGRAF IDEF0 software. According to the process approach, we divided the types of processes available in the company into three types: main processes, management processes, and support processes. Finally, in a meeting attended by all managers, the processes outlined in the iGRAF IDEF0 software were presented and the effectiveness of this process mapping in creating a holistic process approach in the organization was discussed and analyzed.

4. Findings

Figure 3 is the first output of the iGraf IDEF0 software which shows a zero-level diagram of organizational processes map in the Kanya Noor Barzin Zagros Company.

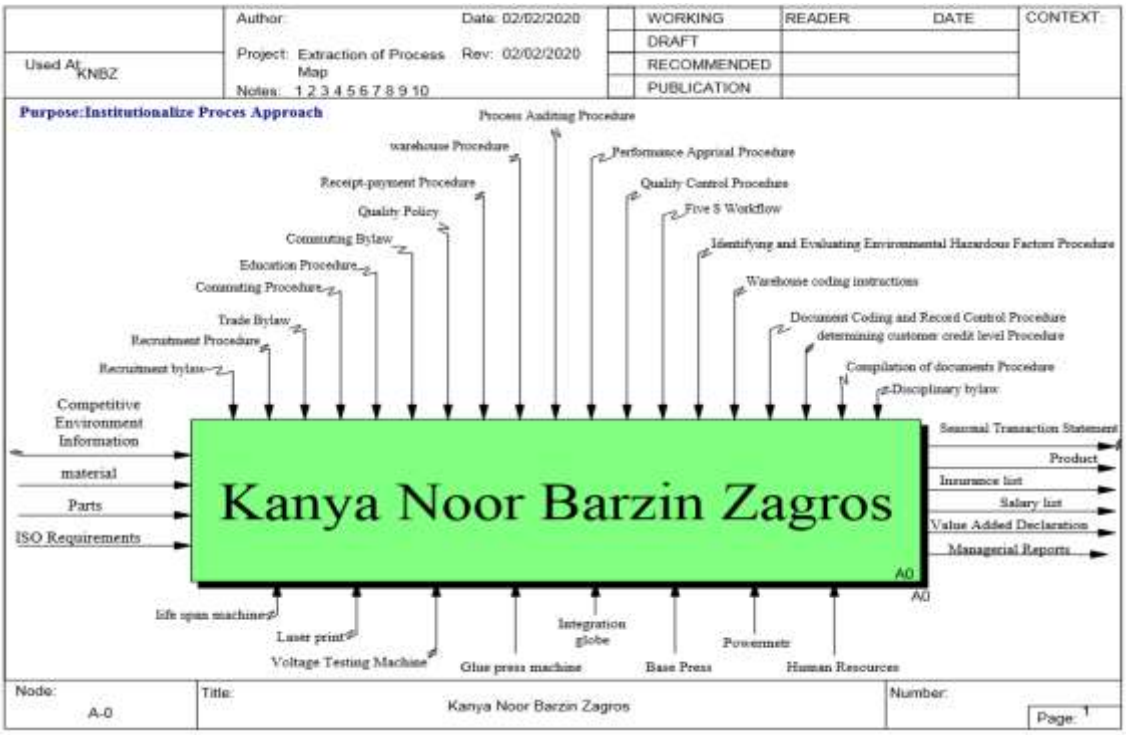

Figure3. Process map of Kanya Noor Barzin Zagros Company (zero-level)

Under creating sub-processes, each of the inputs, outputs, controls, and mechanisms of the main (upper) process must be assigned to the next level and linked to their respective sub-processes. Figure 3 shows the three kinds of processes in the Kanya Noor Barzin Zagros Company.

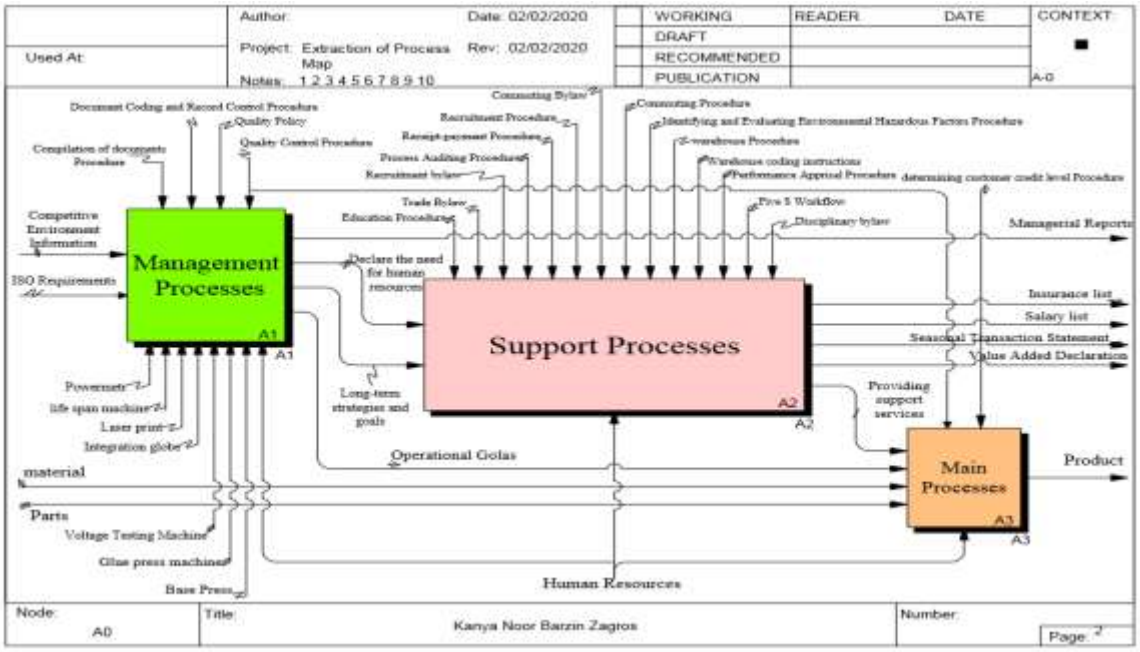

Figure4. Decomposition of box A0: Processes Map of KNBZ Company

As shown in Figure 4, the processes in the company are decomposed into three child processes (functions): management processes, support processes, and main processes. Figure 5 presents the sub-processes required to perform management processes under ISO 9001: 2015 requirements.

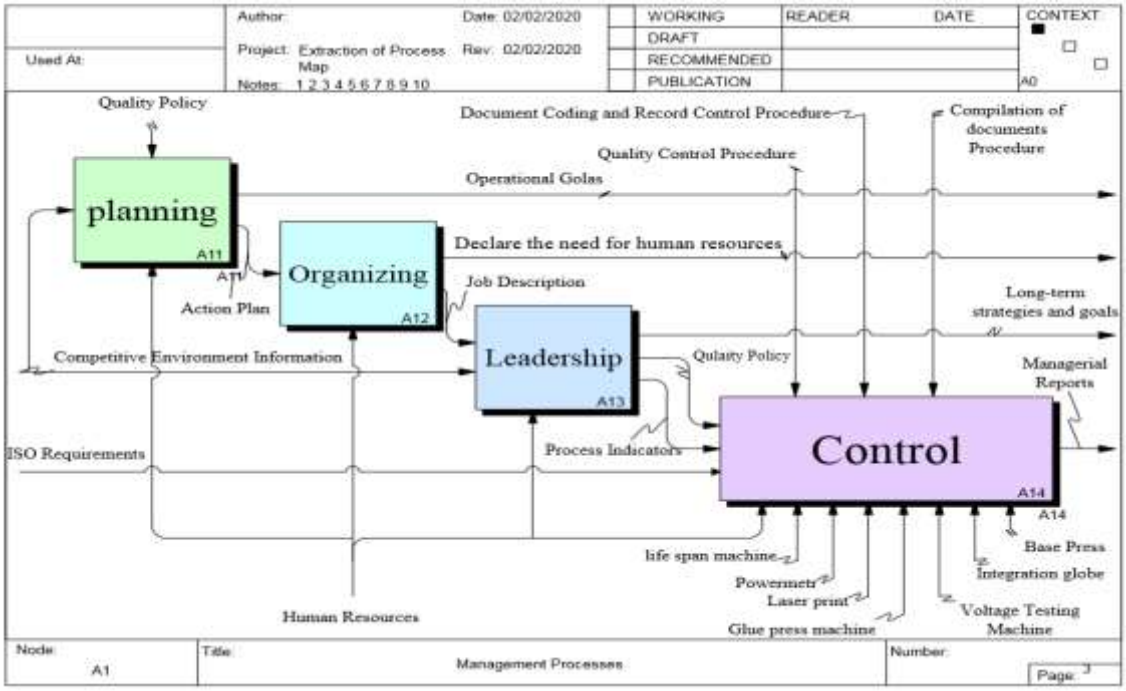

Figure5. Decomposition of box A1, Management Processes

As shown in the figure, management processes in this company are decomposed into four child processes of planning, organizing, leadership, and control. Another type of processes in the company are support processes. Figure 6 shows the expansion of these processes.

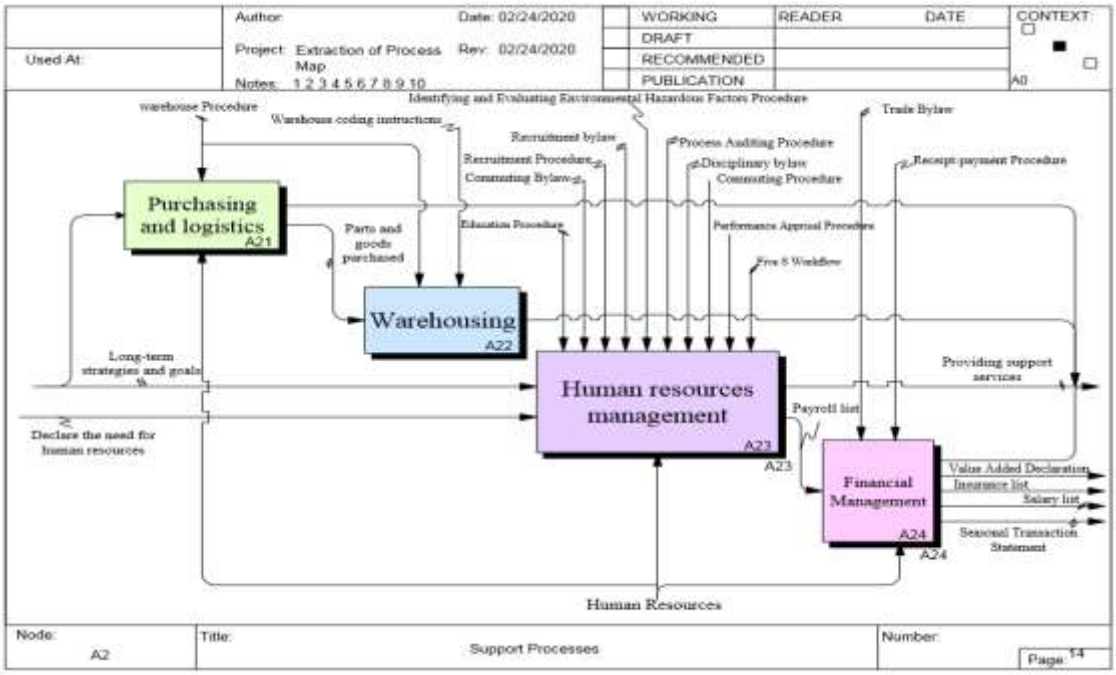

Figure6. Decomposition of box A2, Support Processes

The figure shows support processes under the requirements of clause 7 (support) of ISO 9001: 2015. The sub-processes related to the main processes are shown in Figure 7.

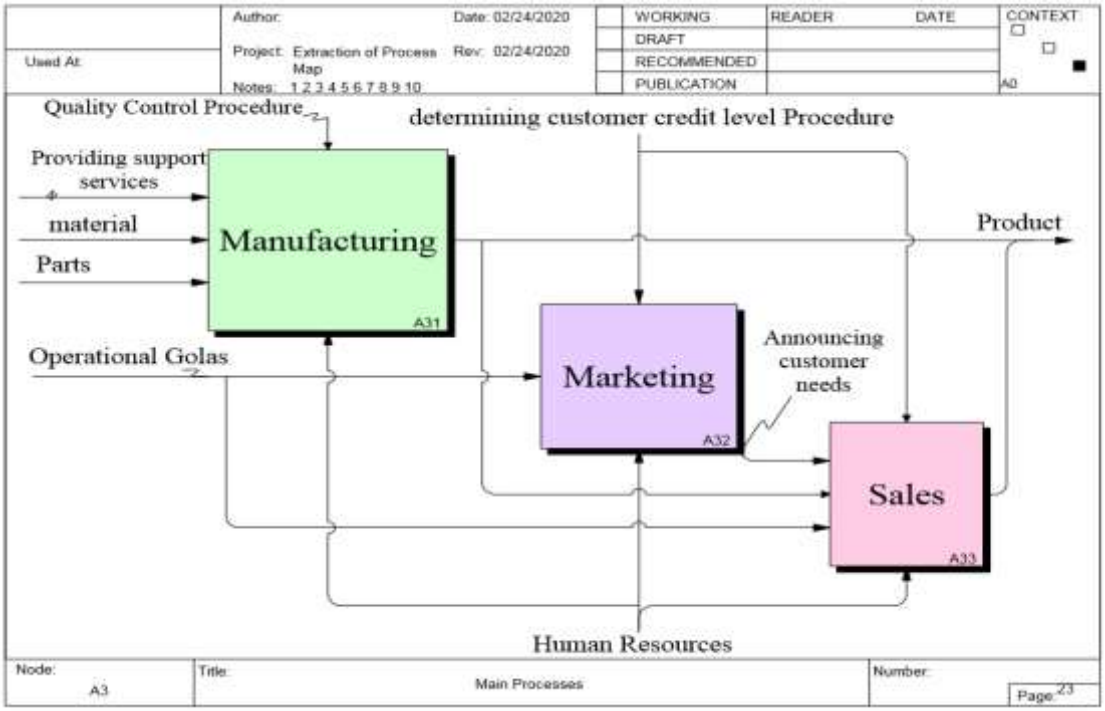

Figure7. Decomposition of box A3, Main Processes

The main processes in the company include three processes: production, marketing, and sales. The company's main mission is to produce all kinds of LED lamps. The following diagram shows the

production process of the company.

As seen in Figure 8, tracing the production process will give a holistic, systematic view of the process involved, in other words, extracting such process diagrams will produce a mental image in a coherent whole. IDEF software can break down processes to the level of activity.

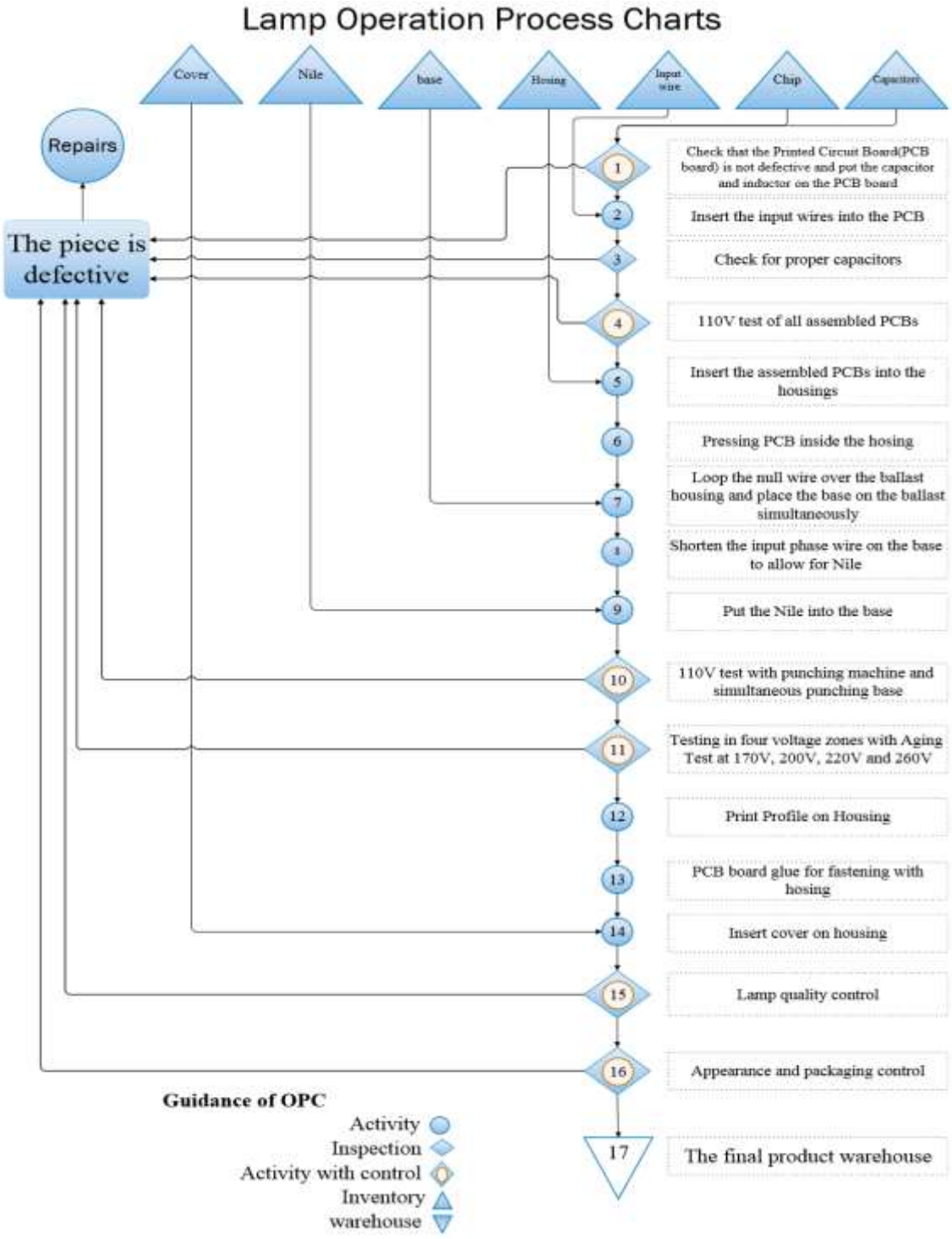

Figure8. OPC of LED Lump Production

5. Results and Discussion

All managers at the company acknowledged that having a business process map created a helicopter view and enhanced their understanding of the process approach to implementing ISO 9001: 2015 requirements. Therefore, given that process orientation is one of the key requirements of ISO 9001: 2015, it can be said that the use of appropriate tools for designing and drawing processes in the organization has become a requirement. So one of the best tools for creating a business process map is to use the IDEF0 standard. Process map extraction with iGraf IDEF0 creates a comprehensive picture of the processes and activities of the organization. These processes maps, first of all, institutionalize the process attitude in the organization, and secondly, represent the documents developed in the ISO standard as controllers of the quality management system. Third, by listing the process mechanisms, it provides a list of all the tools and resources needed to perform the organization's activities. Modeling these processes requires understanding the entire organization and all the requirements and clauses of ISO 9001: 2015. With the proposed modeling of IDEF0, we can draw a comprehensive picture of processes and their relationships so that each viewer can analyze their processes, sequences and their classification, inputs, outputs, controllers and process mechanisms.

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