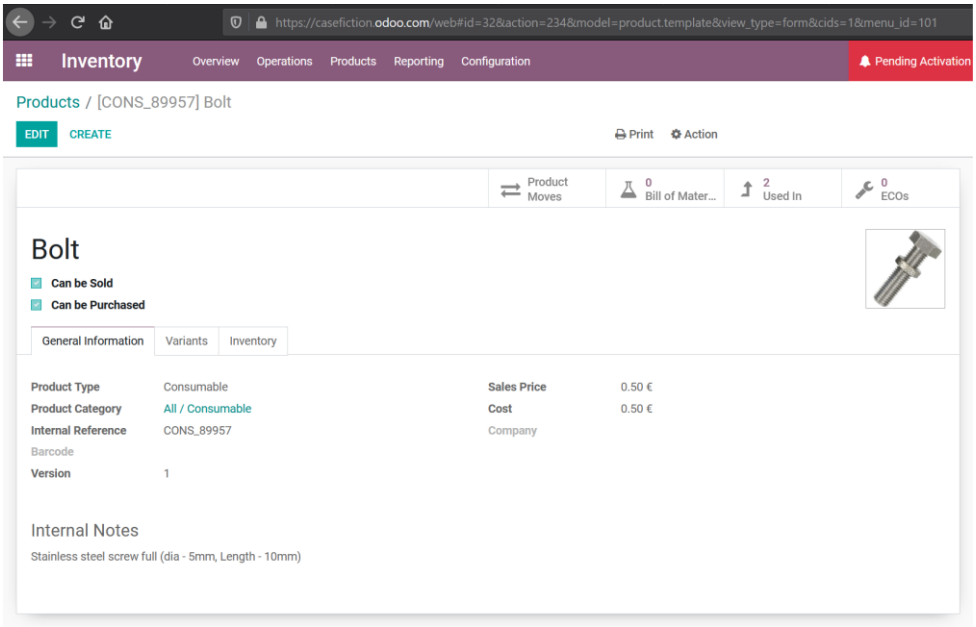


圖 20 展示了特定項目及其元數據的示例，顯示在 GUI 中。

Within Odoo, there are several types of those item classes (some holding a lot of metadata and some holding very little) all with a varying degree of relationships and integration. Since the scope of this work is limited to the PLM and MES capabilities, the focus is on the items that are related to it. The following sections will provide short explanations for the main 7 item classes of Odoo’ s manufacturing process since its basic understanding is helpful for the reader to follow the simulation. These are represented in the following diagram (Figure 21). Other items that are external to the manufacturing procedure will be presented throughout the simulation.

在 Odoo 中，有幾種不同類型的項目類別（有些包含大量元數據，而有些則包含很少），它們之間存在著不同程度的關係和整合。由於這項工作的範圍僅限於 PLM 和 MES 功能，因此重點放在與之相關的項目上。以下各節將對 Odoo 的製造流程中的主要 7 種項目類別進行簡要解釋，因為對其基本理解有助於讀者理解模擬。這些項目在下面的圖表（圖 21）中得到了表示。其他與製造程序無關的項目將在模擬中進行介紹。

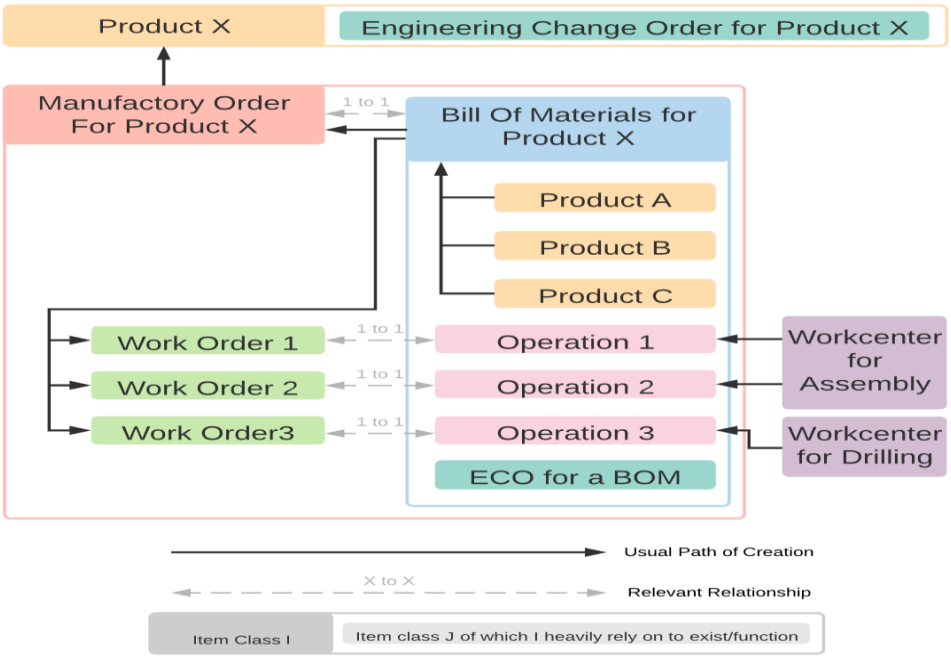


圖 21 簡化的項目關係圖對產品 X 的製造進行了描述。

5.1.3.1. Product Item

Every material, component or product is characterized by a PRODUCT type class that is held and mainly managed within the Inventory application of Odoo. That means that within the system product production is dependent on the availability of other products that are either bought as they are or manufactured from another products (Figure 22), i.e., raw materials are considered products as well, more specifically products that are purchased andthen included in the BOM's to manufacture other products. This is considered the main item class since it is both the source and the goal of manufacturing.

5.1.3.1. 產品項目

每種材料、零件或產品都由一個"PRODUCT"類型的類別來描述，並且主要在 Odoo 的庫存應用中進行保存和管理。這意味著在系統內，產品的生產取決於其他產品的可用性，這些產品可能是直接購買，也可能是從其他產品製造出來的（見圖 22），也就是說，原材料也被視為產品，更具體地說，是被購買並包含在 BOM 中以製造其他產品的產品。這被認為是主要的項目類別，因為它既是製造的來源，也是目標。

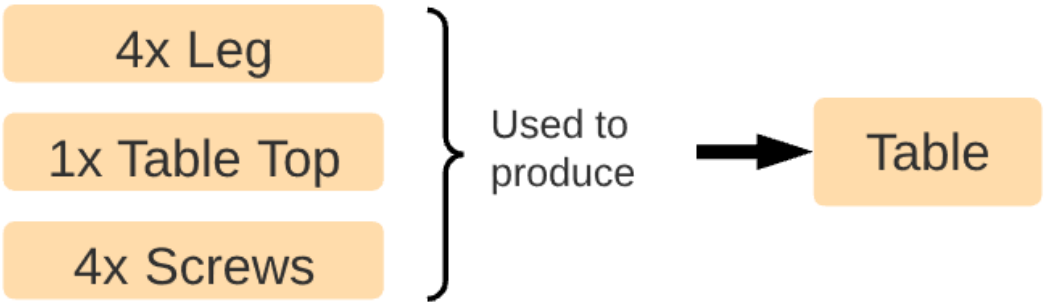


圖 22 簡化的產品關係圖

5.1.3.2. Operation item class and workcenter item class

The operation item is representative of a manufacturing operation that is required to transform components or raw materials into a product or new component while the workcenter item represents the place at which the operation takes place, e.g., a sanding wood will be carried out in a sanding station (Figure 23) that has the proper equipment. The workcenter is eventually used in Odoo as a time/equipment management tool in its production planning. Basically, when the production center is at full capacity it puts following processes on hold or redirects the processes to an alternative workcenter. The operation item is also responsible for holding the instruction files that are consulted during production.

5.1.3.2. 操作項目類和工作中心項目類

操作項目代表必須將零部件或原材料轉化為產品或新零件所需的製造操作，而工作中心項目則代表進行操作的地點，例如，對木材進行砂磨將在一個具有適當設備的砂磨站（見圖 23）進行。在 Odoo 中，工作中心最終被用作生產計劃中的時間/設備管理工具。基本上，當生產中心達到滿負荷時，它將暫停以下流程或將流程重定向到替代工作中心。操作項目還負責保存在生產過程中咨詢的指示文件。

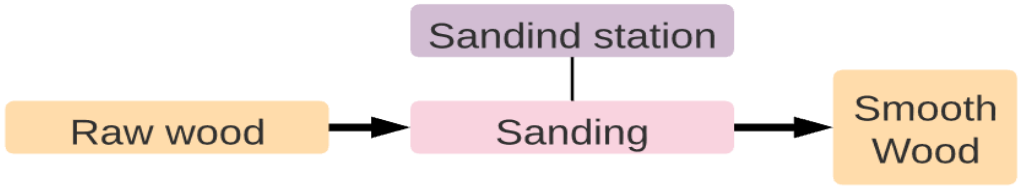


圖 23 簡化操作圖

5.1.3.3. The Bill of Materials item class

The Bill of Materials is a list of components necessary to build a product. In Odoo, however, the BOM is best described by what PLM would consider the virtual representation of the production process. That might seem counter intuitive at first considering the previously mentioned operation item class, but in fact since the BOM is a compound item it points directly to all item types necessary to produce the end product (Figure 24). For example, let's say that to build a product it is required 3 different parts and 4 different operations; the BOM of said product would list all of them as well as specify the order in which these are utilized.

5.1.3.3 物料清單項目類別

物料清單是建立產品所需組件的清單。 然而，在 Odoo 中，BOM 最好透過 PLM 認為的生產流程的虛擬表示來描述。 乍一看，考慮到前面提到的操作項目類，這似乎違反直覺，但事實上，由於 BOM 是複合項目，它直接指向生產最終產品所需的所有項目類型（圖 24）。 例如，假設要建構一個產品，需要 3 個不同的部分和 4 個不同的操作； 所述產品的 BOM 將列出所有這些，並指定它們的使用順序。

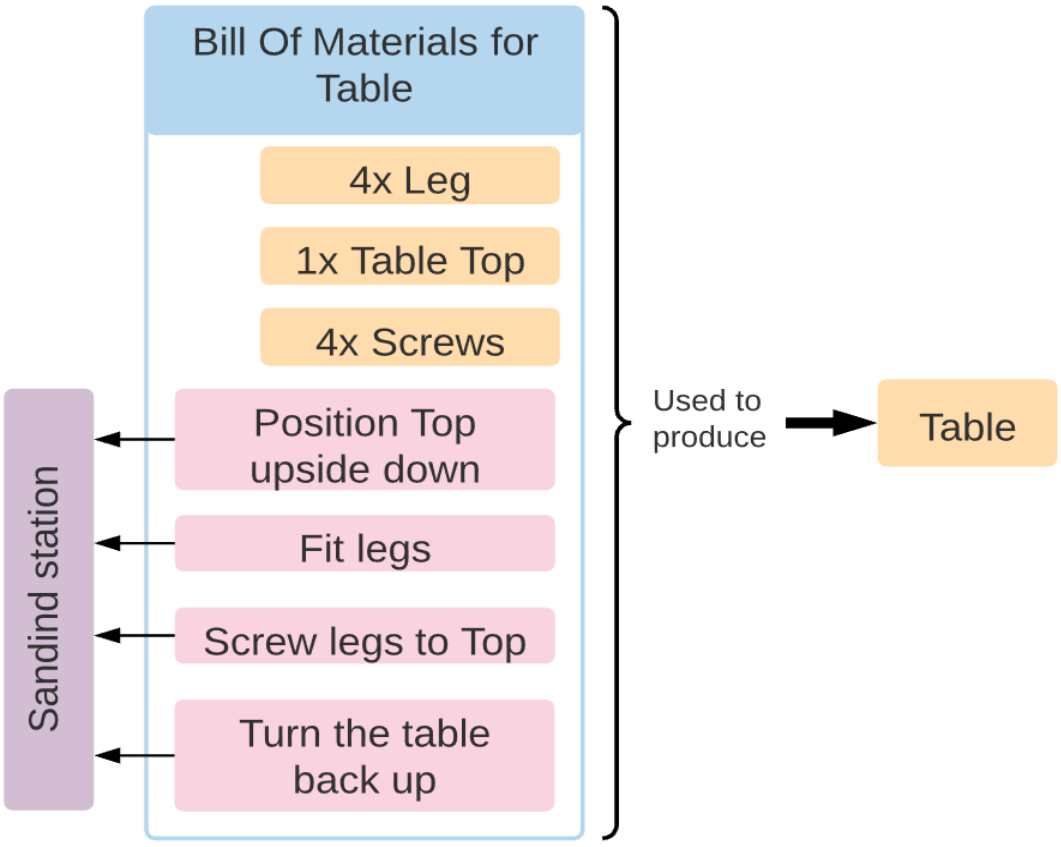


圖 24 簡化的 BOM 圖解

5.1.3.4. Manufacturing order item class and work order item class

Along the standard items that are considered within Odoo, orders are the ones that represent commencement within the system. They are signaling that a change is taking place somehow and somewhere. In the case of a manufacturing order it represents the order to manufacture N number of specific products using it's BOM as a base. It is as consequence of that MO that work orders are automatically generated by Odoo (one for each necessary operation listed in the BOM) and allocated throughout available necessary workcenters (Figure 25).

在 Odoo 中，訂單是系統中開始的代表。它們表明某種變化正在某個地方發生。對於製造訂單來說，它代表了使用其 BOM 作為基礎製造特定產品的 N 個數量的訂單。正是由於這個製造訂單，Odoo 會自動生成工作訂單（每個工作訂單對應 BOM 中列出的每個必要操作）並分配到所有必要的工作中心。

The work order is the main form in which the manufacturing operators interact with Odoo, it presents all the instructions specified by the operation item, as well as control towards its completion. When a WO takes place the operator signals through the interface its beginning, its completion and even any quality control check points required while the system keeps track of timing and performance (Figure 26). Once all WO are done the MO can be declared done and the materials and components specified in the BOM are consumed and the N copies of the product is added to inventory. All that makes the work order a central piece as far as MES is concerned.

工作訂單是製造運營人員與 Odoo 交互的主要形式，它呈現了操作項目指定的所有指示，以及對其完成的控制。當工作訂單進行時，操作員通過界面表示其開始、完成甚至任何質量控制檢查點，而系統則跟蹤時間和性能。一旦所有工作訂單完成，製造訂單就可以被宣告完成，並且在 BOM 中指定的材料和組件被消耗，並將 N 個產品的副本添加到庫存中。所有這些使工作訂單在 MES 方面成為一個中心件。

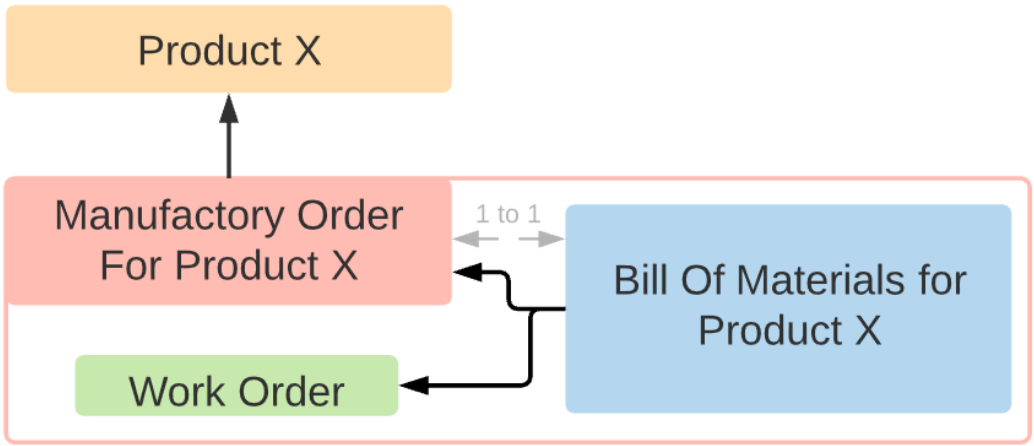


圖 25 簡化的訂單圖表

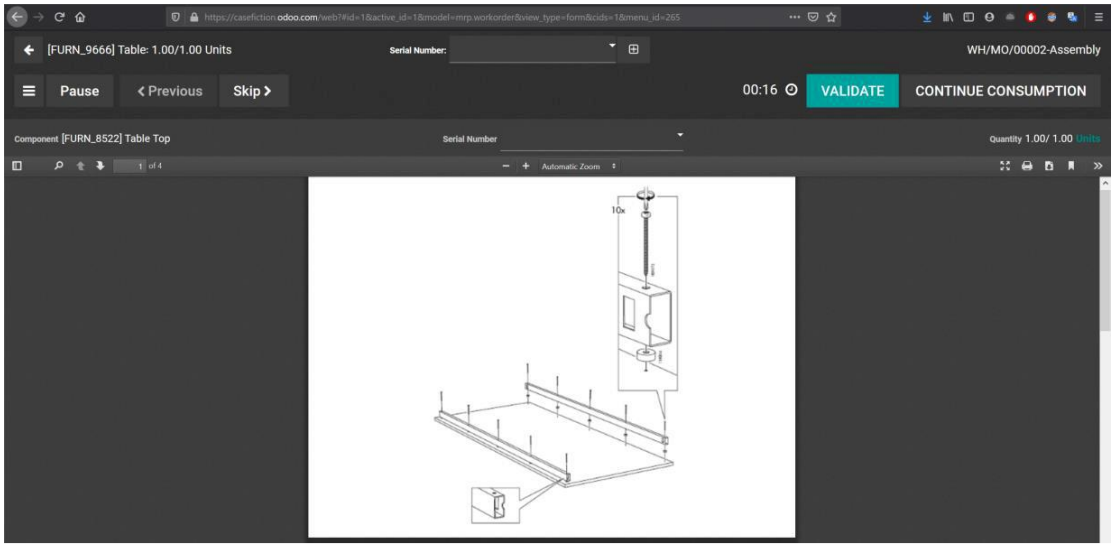


圖 26 工作訂單期間的操作員界面

5.1.3.5. The engineering change order

As explained in the beginning of chapter 2 the Odoo management software considers PLM mainly as a tool for tracking change and improvements. Its application module is external to the normal flow of manufacturing but acts as an expansion to it. Its focal item class is the Engineering Change Order (ECO).

5.1.3.5. 工程變更訂單

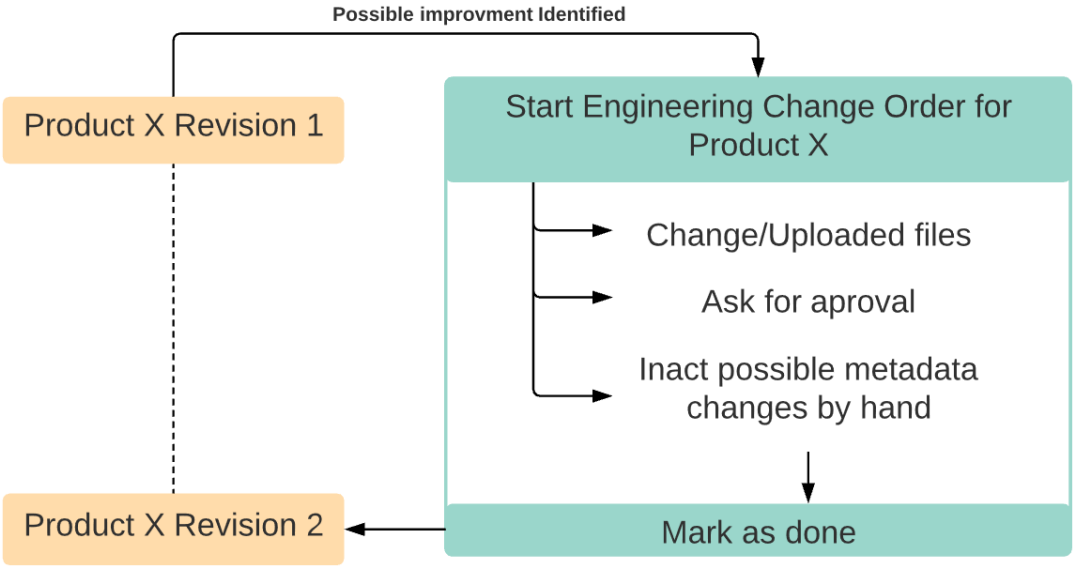
正如第二章開頭所解釋的，Odoo 管理軟件主要將 PLM 視為追踪變更和改進的工具。其應用模塊與製造的正常流程外部相連，但作為其擴展。其主要項目類別是工程變更訂單（ECO）。

An ECO is an item class that outlines the proposed changes to the product or the parts that would be affected by the change. In other words, is a central information hub for everyone associated with a given product.

ECO 是一個項目類別，概述了對產品或受到變更影響的零件的建議變更。換句話說，它是與特定產品相關聯的每個人的中心信息中心。

The idea is to signal the need for change to a product item or a BOM item, hold the files that are relevant to the change and apply the change or at least signal that the change has been implemented, all while keeping the history of al the previous changes. All very useful in the future and serve as a process to streamline product development and help improve products/production.

這個想法是向產品項目或 BOM 項目發出變更需求信號，保存與變更相關的文件，並應用變更，或者至少發出變更已實施的信號，同時保留所有先前變更的歷史。這些都非常有用，可以作為未來的流程，用於簡化產品開發並幫助改善產品/生產。



5.2.Starting the simulation

5.2.1. Software option chosen for the simulation

For this simulation, it has been decided that the best evaluation of the Odoo software would be through its online web-based service. The reasons for such choice instead of using the community edition of the software are as follows:

5.2.1. 模擬中選擇的軟件選項

對於這次模擬，決定通過其在線 Web 服務對 Odoo 軟件進行最佳評估。與使用軟件的社區版本相比，做出這樣的選擇的原因如下：

▪ The practicality of using a web-based service as oppose to administrate a server locally or remotely. Although the community application was tested as part of the research for this work and has been judged to be a very beginner friendly server application the fact of the matter is that hosting a server is, on its own, a job that requires experience and knowledge. There has been a shift of the market regarding this sort of application towards product as a service and with good reason. At the time this thesis is being written the COVID-19 pandemic is forcing a lot of employees to work remotely and making clear to the market that IT is not a simple job and that a web service is an attractive option.

▪ 使用基於 Web 的服務相對於本地或遠程管理服務器的實用性。雖然社區應用程序作為本研究的一部分進行了測試，並且被判斷為非常適合初學者的服務器應

用程序，但事實是，單獨運營服務器是一項需要經驗和知識的工作。關於這種應用程序的市場已經發生了轉變，向產品作為服務的方向轉變，並且有充分的理由。在撰寫本論文時，COVID-19 大流行迫使許多員工遠程工作，向市場明確表明，IT 並不是一個簡單的工作，而 Web 服務是一個有吸引力的選擇。

▪ Lack of official Odoo PLM application for the community edition of Odoo. Although there is a substantial repertoire of community made applications for the community edition of Odoo the organization, description, integration, and support of this applications are spotted at best. Rather than rely on applications that might not keep up with the main software it was decided that it would be a fairer to the platform evaluation if it was based on official applications. I.e. it would be very unproductive to slap together a free solution just to depend on luck regarding how it is supported on the future. PLM is the focus here, so this is an unnegotiable situation.

▪ 缺乏 Odoo 社區版的官方 PLM 應用程序。雖然 Odoo 社區版有大量由社區製作的應用程序，但這些應用程序的組織、描述、集成和支持程度最多只能說是參差不齊。與其依賴可能跟不上主要軟件的應用程序，不如基於官方應用程序對平台進行公平評估更為明智。換句話說，隨意拼湊一個免費解決方案，然後依靠未來的支持來說，這是非常不生產的。PLM 是重點，因此這是一個不可妥協的情況。

At the time of writing this work, Odoo allows you to select one of its extra features like PLM and use it for free for an indefinite amount of time on their cloud hosted servers. This is a very attractive option if the only focus of this work was PLM and manufacturing. However, the MES aspect of this work is highly dependent of other applications of Odoo which means that there is very little that can be done. To this end the experiment was carried out in the trial version of Odoo enterprise which allow the user to use the system without storage or application limitations for a period of 14 days all hosted in Odoo cloud servers (Figure 17).

在撰寫本作品時，Odoo 允許您選擇其額外功能之一，如 PLM，並在其雲端托管的服務器上無限期地免費使用。如果這份工作的唯一重點是 PLM 和製造，這將是一個非常有吸引力的選擇。然而，這份工作的 MES 方面高度依賴於 Odoo 的其他應用程序，這意味著幾乎無法做任何事情。為此，實驗是在 Odoo 企業版的試用版中進行的，該版本允許用戶在 Odoo 雲端服務器上無限制地使用系統，沒有存儲或應用程序限制，使用時間為 14 天（見圖 17）。

5.2.2. Setings details that are relevant

A few details regarding the settings of Odoo are relevant to the proper function of its manufacturing functionalities. Namely enabling work orders in the manufacturing settings is an obligatory step for proper use of both work order items, workcenter items and operation items.

5.2.2. 相關的設置細節

關於 Odoo 的設置有一些細節與其製造功能的正常運作息息相關。特別是在製造設置中啟用工作訂單是正確

An assumption made for this work is that this is a holdover of the ERP origins of the software because it is rather unintuitive to not have this setting enabled by default if you are going to use Odoo to make any serious control on manufacturing. Regardless as of Odoo enterprise v14 this option can be set in the Settings > Manufacturing > Operations > Work Orders (Figure 28).

在這份工作中做出的一個假設是，這是軟件起源於 ERP 的延續，因為如果您要在 Odoo 上對製造進行任何嚴肅的控制，將此設置預設為未啟用是相當不直觀的。儘管如此，截至 Odoo 企業版 v14，可以在「設置」>「製造」>「操作」>「工作訂單」（見圖 28）中設置此選項。

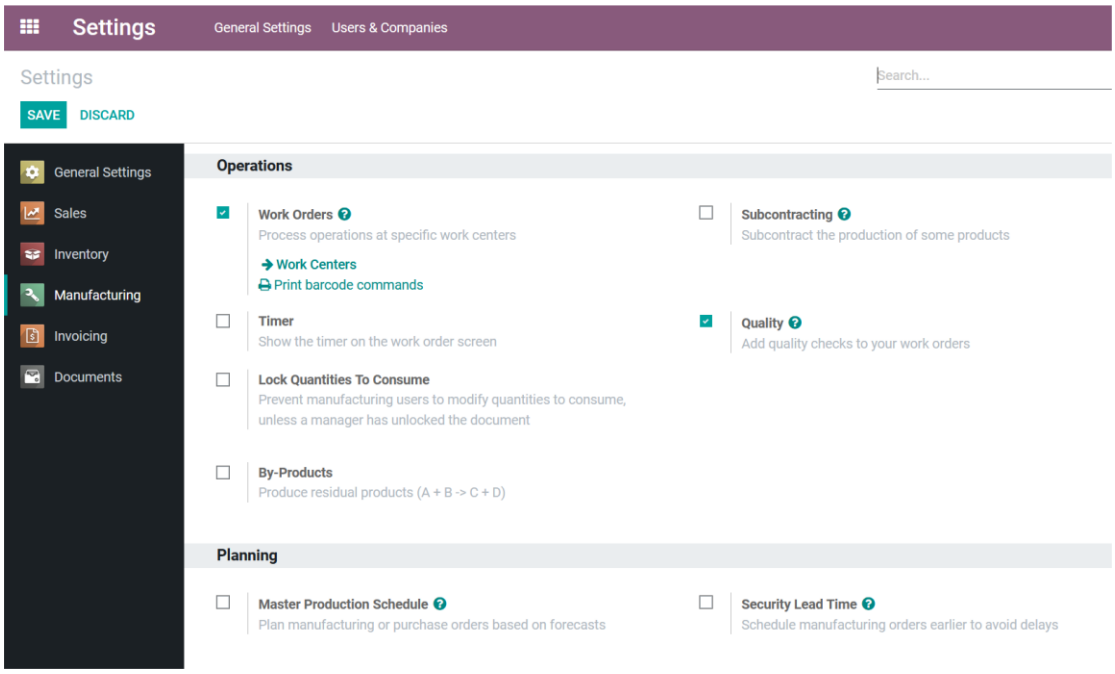


圖 28 啟用特定設置的截圖

5.3.Building the company structure

5.3.1. Users

Users are set and invited through the setting menu. It is possible to assign different levels of permissions regarding different aspects of the business operation. Messaging, permissions, approvals, responsibilities are all assigned into a user. This is very convenient and can fall within the category of virtual item class even if it has limited use in the scope of manufacturing. Their creation is not strictly necessary, the software would run just fine having just me as a user with full administrator credentials, but for this simulation, 5 users were created as listed below to represent different employees within the company. The following (Figure 29) is a screenshot of my user account item and its 'Asses Rights' followed by one of the fictional users being created for the company (Figure 30).

用戶是通過設置菜單進行設置和邀請的。可以分配不同層次的權限，涉及業務操作的不同方面。消息、權限、批准、責任都分配給一個用戶。這非常方便，即使在製造範圍內使用有限，也可以歸入虛擬項目類別。它們的創建並不是絕對必要的，軟件可以運行得很好，只需我作為具有完整管理員憑據的用戶，但在這次模擬中，創建了以下列出的 5 個用戶，代表公司內的不同員工。以下（見圖 29）是我的用戶帳戶項目及其"評估權利"的截圖，接下來是為公司創建的一個虛構用戶（見圖 30）。

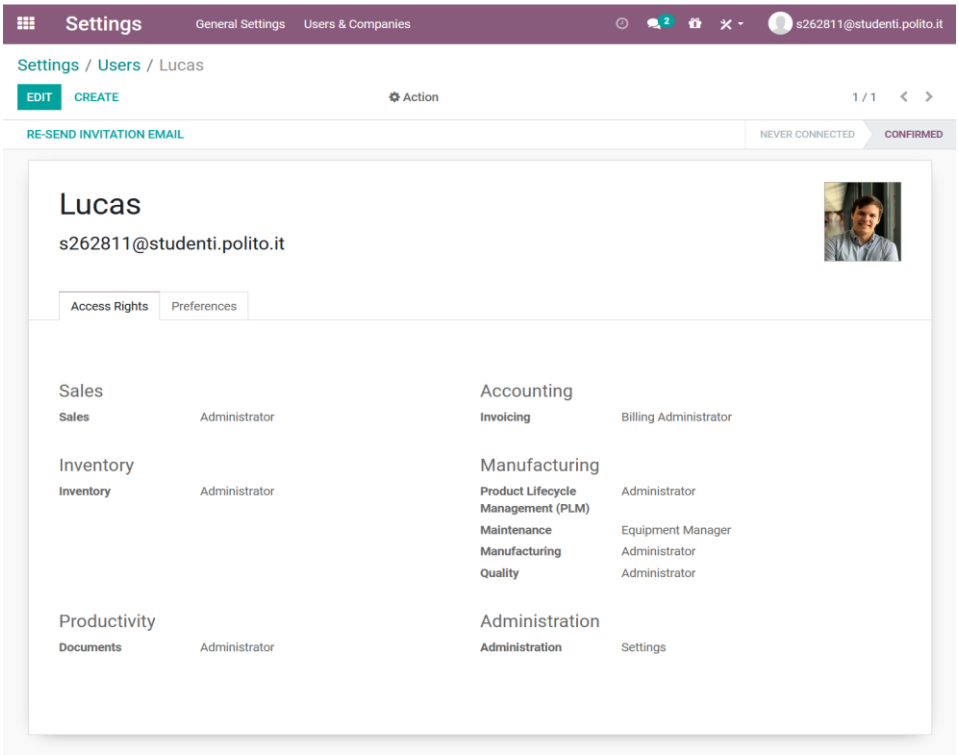


圖 29 用戶帳戶界面截圖

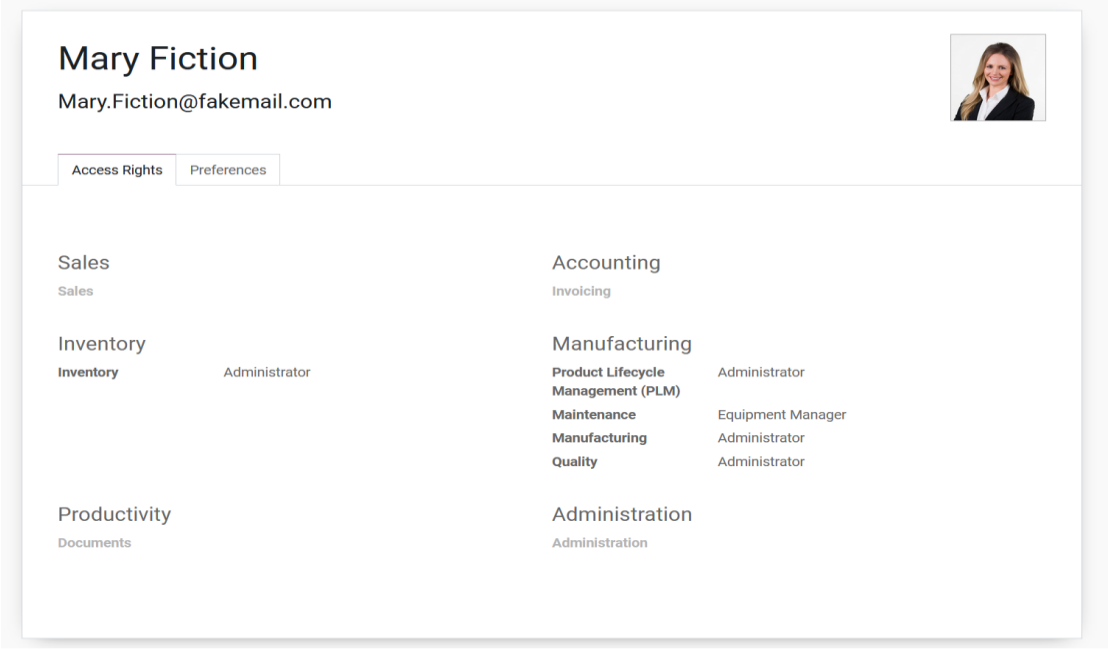


圖 30 第二個用戶帳戶界面截圖

It is nice to point out how the two differ in access rights. Mary Fiction has been created in this example as an engineer and therefore most of her permissions are around the manufacturing procedure while she is denied access to other parts like Sales or Accounting.
很好地指出兩者在訪問權限上的差異。在這個例子中，瑪麗·費雯特被創建為一名工程師，因此她的大部分權限都圍繞著製造程序，而她被拒絕訪問其他部分，如銷售或會計。

5.3.2. Workcenters and Equipement

Workcenters are quite flexible within Odoo in the sense that they can be changed and expanded as needed. One could create the workcenters after creating the product items to allow for reorganization of the shop floor once you gained some perspective on what the products will be in the end. However, for most scenarios this seems unrealistic since the workcenters are more rigid structures in the real world - they don't change as much as the products since they tend to hold heavy machinery.

5.3.2. 工作中心和設備

在 Odoo 中，工作中心在某種程度上非常靈活，因為它們可以根據需要進行更改和擴展。一個人可以在創建產品項目後創建工作中心，以便在獲得對最終產品有所了解後重新組織車間。然而，對於大多數情況來說，這似乎是不現實的，因為工作中心在現實世界中更多地是固定結構——它們不像產品那樣經常變化，因為它們往往擁有重型機械。

In this simulation it was considered that the company already has 3 workcenters from the get-go and therefore the workcenters and machinery were created beforehand. This

is more useful for possible readers interested in implementing Odoo as well as saving sometime.

在這個模擬中，考慮到公司從一開始就已經擁有了 3 個工作中心，因此工作中心和機器已提前創建。這對於有興趣實施 Odoo 的潛在讀者來說更加有用，同時也能節省時間。

We begin by creating the equipment we have. This is an item class that emphasizes in maintenance organization. The application responsible for managing equipment is the Maintenance App. The following image is an example of how Odoo portrays a 3D printer equipment item (Figure 31).

我們首先創建我們擁有的設備。這是一個強調維護組織的項目類別。負責管理設備的應用程序是維護應用程序。以下圖片是 Odoo 如何展示一個 3D 打印機設備項目的示例（見圖 31）。

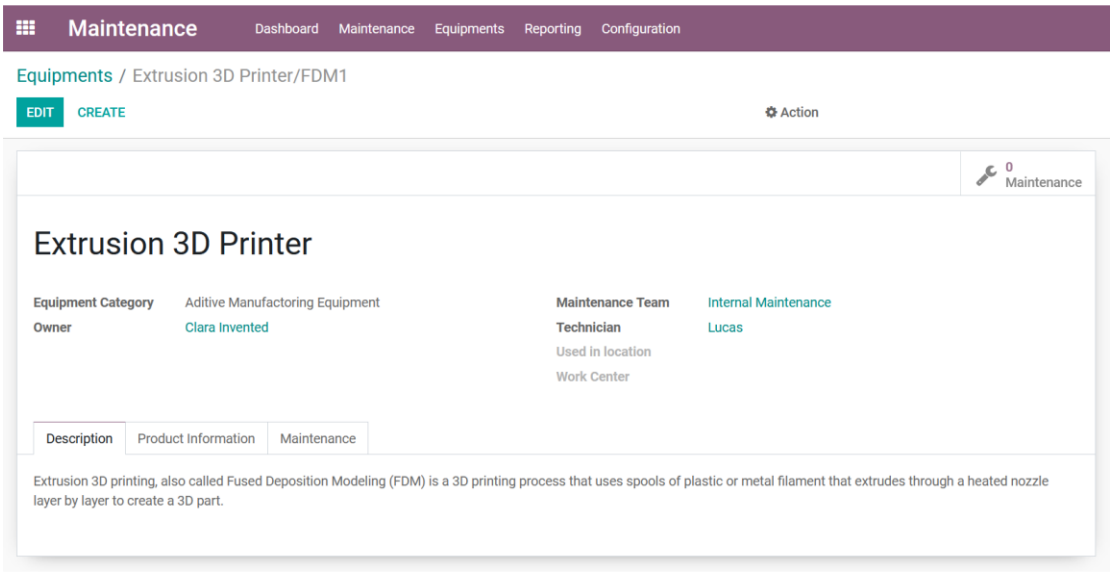


圖 31 Odoo 3D 打印機設備項目

In addition to this 3D printer the following equipment were created to be used throughout the development/production process (Figure 32):

除了這台 3D 打印機之外，還創建了以下設備，用於整個開發/生產過程（見圖 32）：

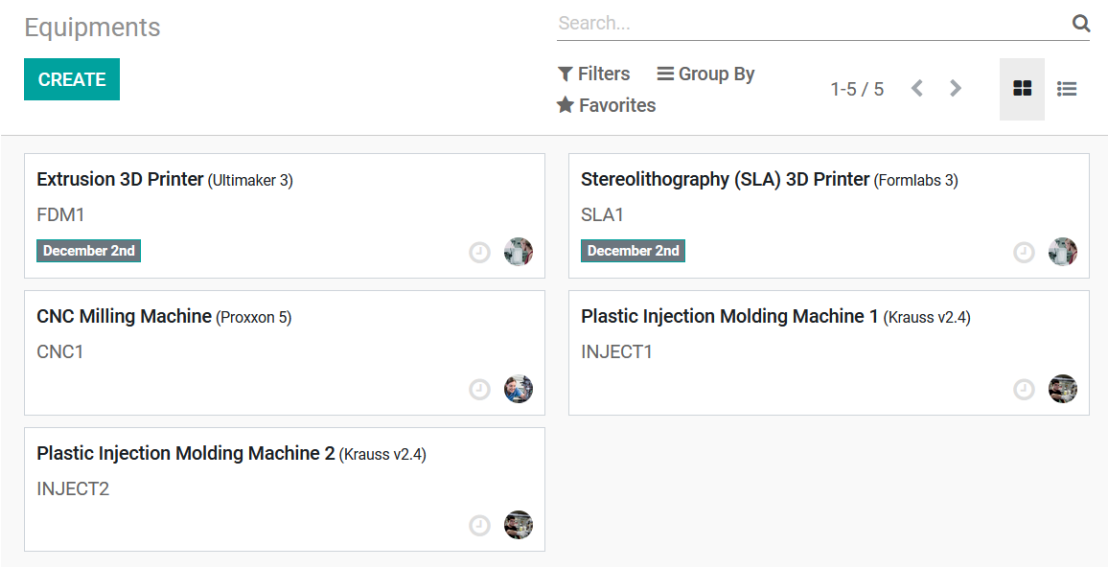

Equipments
CREATE
Search...
Filters
Group By
Favorites
1-5 / 5
Extrusion 3D Printer (Ultimaker 3)
FDM1
December 2nd
Stereolithography (SLA) 3D Printer (Formlabs 3)
SLA1
December 2nd
CNC Milling Machine (Proxxon 5)
CNC1
Plastic Injection Molding Machine 1 (Krauss v2.4)
INJECT1
Plastic Injection Molding Machine 2 (Krauss v2.4)
INJECT2

圖 32 設備項目概覽