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PENGABDIAN KEPADA MASYARAKAT

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A Method for Manufacturing Execution Systems Design using ISA-95

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Background for MES Implementation

- Competition has forced manufacturing companies to increase their ***flexibility, agility, efficiency and quality of their processes***
- One way that can be done is ***enhancing the integration of processes in highly automated environments***. This integration is especially necessary in collaborative contexts such as extended enterprise
- A lot of manufacturing companies focus on **implementing MES** *solution* ***to provide visibility and flexibility and effectively manage supply chain***

Defining MES

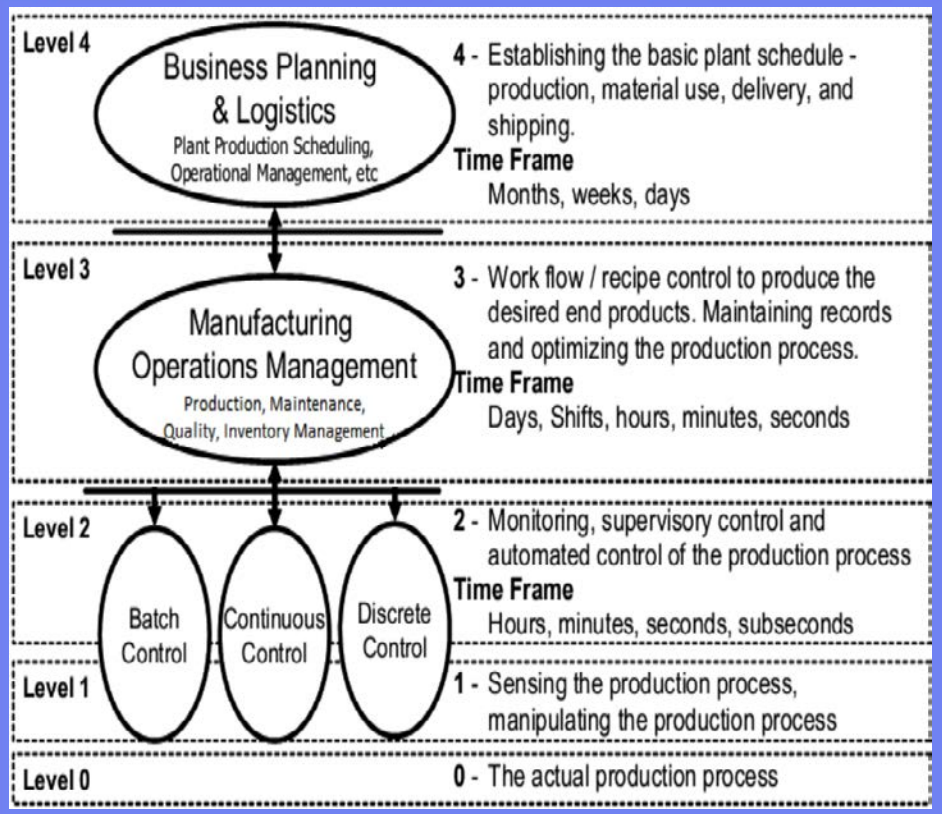
Sourcer: Deuel, 1994

Manufacturing execution system is information systems (IS) that bridges the gap between IS at the top level, namely enterprise resource planning (ERP) nd IS at the lower levels, namely the automation systems.

MES provides an electronic and real-time media to optimize the manufacturing process as a whole.

Defining MES

- MES are at the heart of computer integrated manufacturing (CIM).
- MES is placed at the middle ground between ERP systems and individual machine and automation controls.
- ERP systems handle financial functions, customer orders and send production requests to the factory floor.
- MES provide overall control and management of the factory floor, and provide updated information the ERP.



MES system hierarchy

(Source: ANSI/ISA-95.00.03–2005, 2005, p. 20

In many cases, manufacturing companies have implemented ERP systems and Level 2 systems (shop floor automation systems)

MES helps ERP system to work together with SHOP FLOOR AUTOMATION SYSTEMS to manage the plant

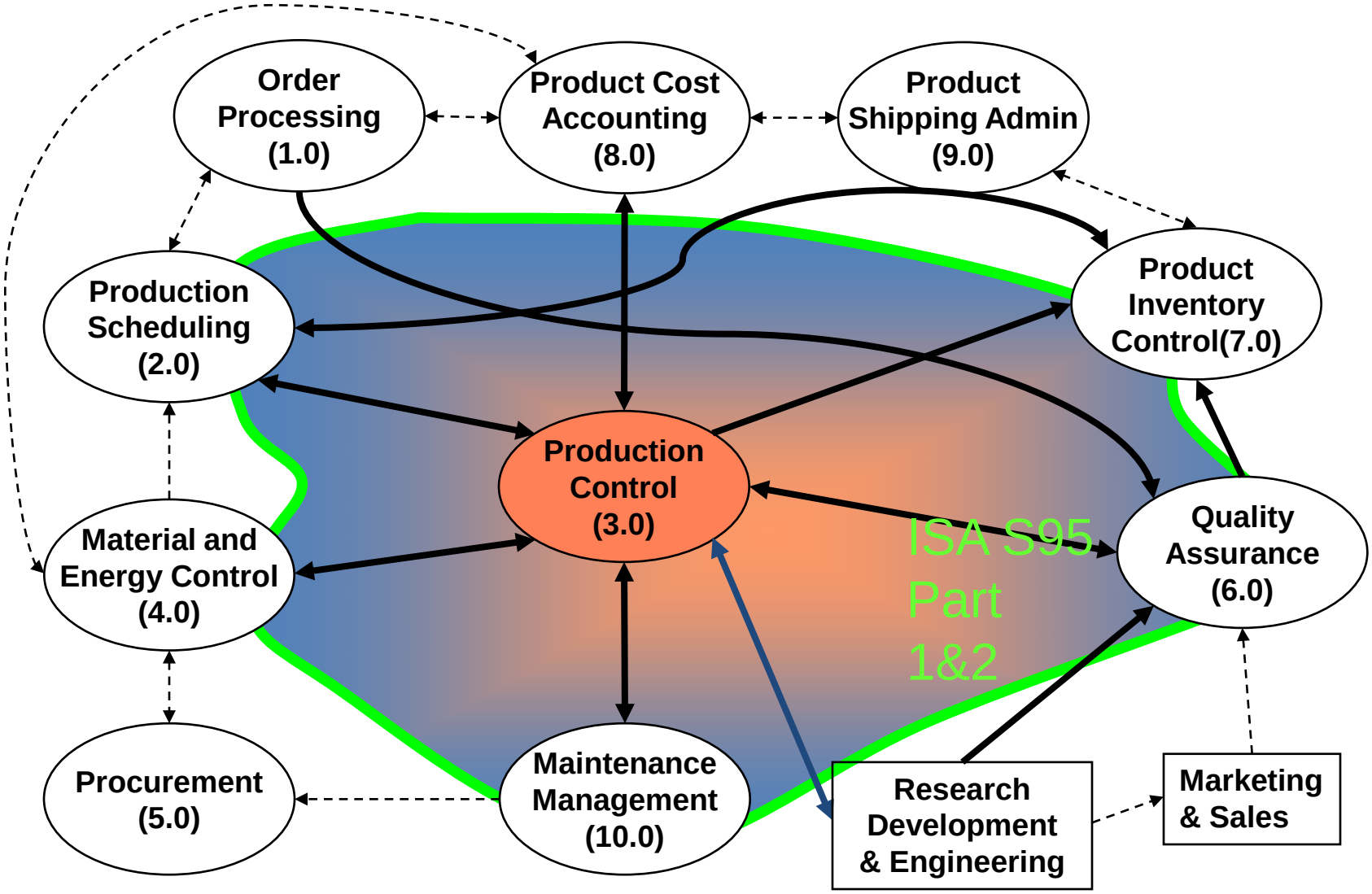
Research Problem - 1

- Implementing MES and the Integration of ERP and MES have been a big challenge for manufacturing companies.
- In implementing MES, functional integration is the most difficult challenge --making all the components of the manufacturing system able to work well together
- The ANSI/ISA-95 standard is one of the widely used standard (reference model) because it specifies a complete functional model to integrate the business and manufacturing layers, and defines the information to be exchanged between levels 3 and 4.

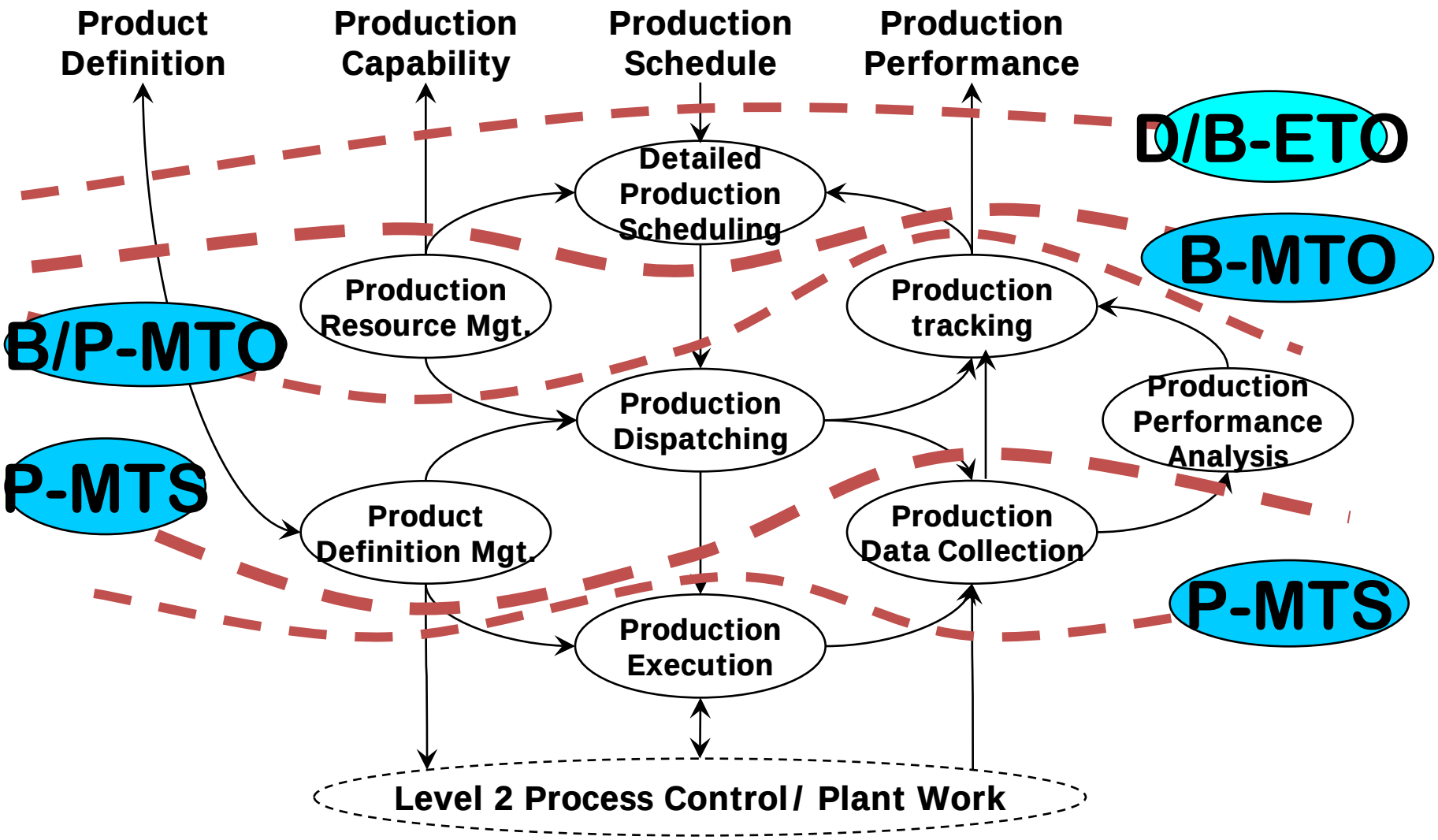
Research Problem - 2

- Focusing on manufacturing domain, a number of works can be found in the literature related to production/manufacturing information systems design methodology, i.e. Hadjimichael (2004), Cao (2008), dan Waldron (2011)
- Methodologies proposed by Hadjimichael (2004), Cao (2008), dan Waldron (2011) did not address the use reference models and none of the works provide a methodology as a guideline in designing MES.

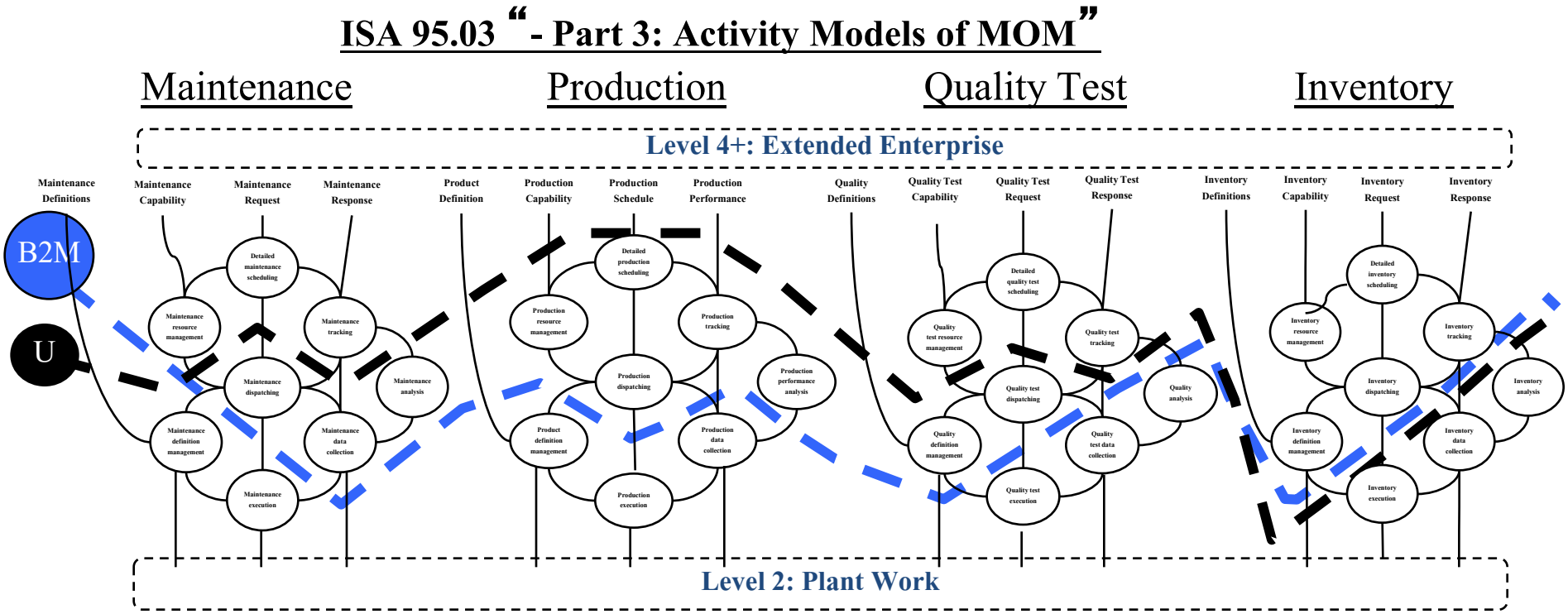
ISA-95 Functional Enterprise-Control Model



Production operation management



Generic activity models



Support of ISA 95

As shown in the pictures, the ISA-95 standard helps to define:

- the scope of the manufacturing control domain
- the functions and activities associated with the interface between control functions and enterprise functions
- the information which is shared between control functions and enterprise functions

*In order to **contribute to the integration of enterprise and manufacturing processes in a unified way**, this study proposes a methodology to design MES utilizing the ANSI/ISA-95 standard (reference model).*

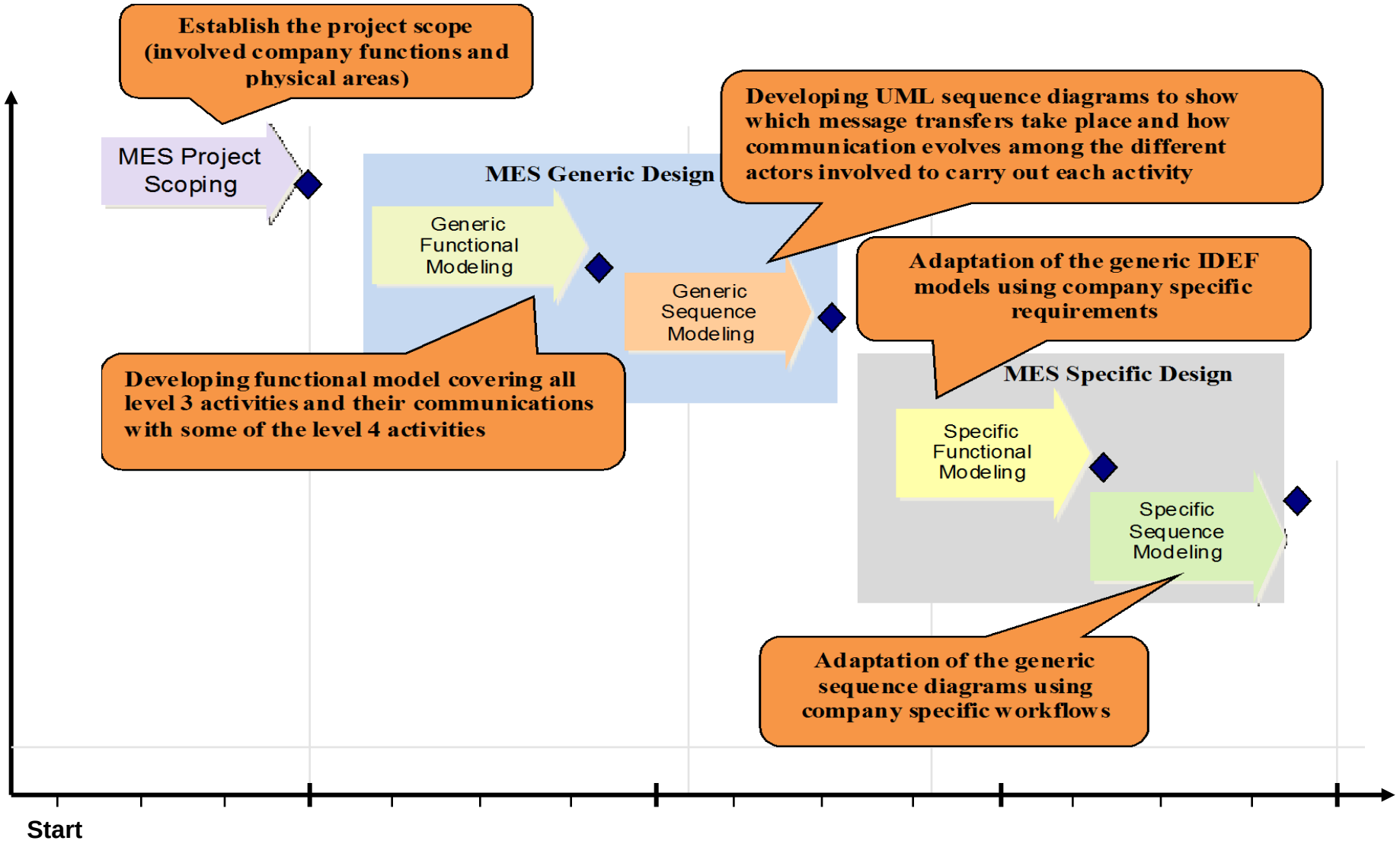
Research objective

- To propose a methodology to design manufacturing execution systems (MES) application utilizing the support of ISA-95 reference model

Research methodology

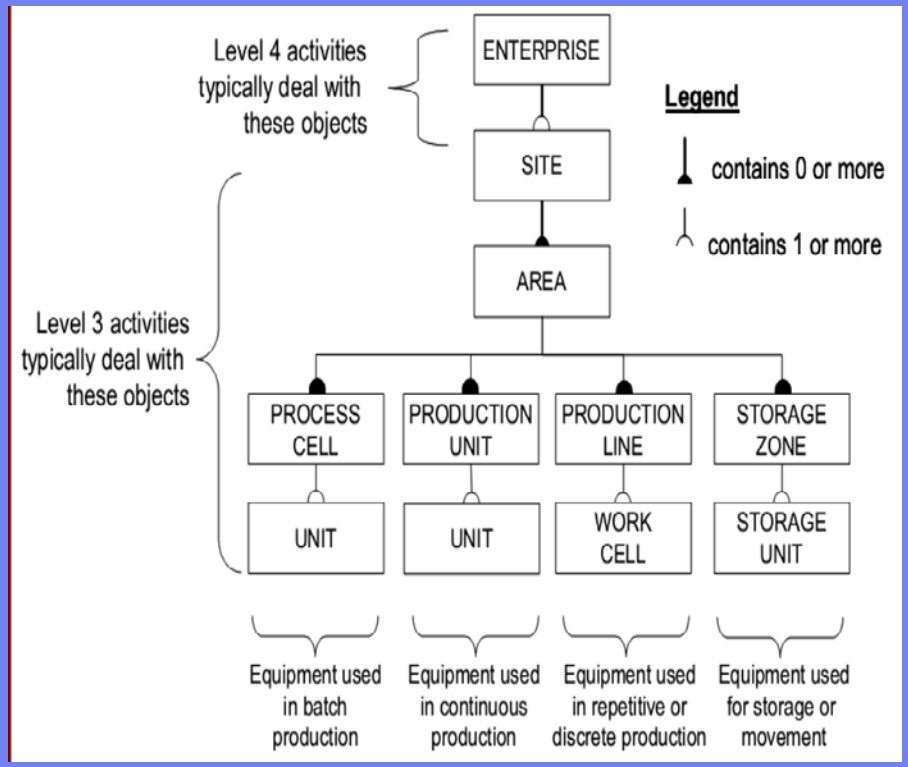
- Literature study to collect information about current manufacturing execution management (control) challenges
- Literature study regarding the ERP and shop floor systems integration process
- Defining a proposed methodology
- Pilot testing of the proposed methodology using a steel manufacturing company case

Proposed Design Methodology



MES Project Scoping

- First of all is necessary to establish the project scope (involved company functions and physical areas). This is very important for further analysis.
- To determine the functions covered in the design process, MES generic activity model from ISA-95.03 part 3 (Activity modle of manufacturing operation management) can be used as a guidance.
- Standard hierarchical organization (Site, Area, Cell, Unit) from ISA-95 can be used in determining the scope of physical areas being covered.



MES equipment hierarchy model

(Source: ANSI/ISA-95.00.03–2005, 2005, p. 20)

- Hierarchical models of equipment in ISA-95 show the hierarchy of the physical assets of the enterprises engaged in manufacturing activities.

Equipment hierarchy model can be used to determine the physical boundary of the MES system (Scholten & Schneider, 2010).

Designing MES Generic Model

Generic functional model:

- ANSI/ISA-95 part 1 (Models and terminology, 2000) and part 3 (Activity models of manufacturing operations management, 2005) helps to identify the main manufacturing operations management related activities.
- They also help to identify the information flowing through the activities of the company.
- A boundary is represented to differentiate between activities at level 3 and activities at level 4. Only a few activities are carried out at both levels.

Designing MES Generic Model

Generic functional model:

•IDEF0 is chosen to model the functional requirements of the system. The detailed level of the modeling is determined by the development team.

•A generic IDEF0 functional model is defined, covering all level 3 activities and their communications with some of the level 4 activities.

•With ISA-95, the functional model is developed in such a way that it separate the business processes from the manufacturing processes. This way, it allow changes in production processes (level 3) take place without requiring unnecessary changes in ERP (level 4) processes.

Designing MES Generic Model

Generic sequence diagram:

- Information about the order in which different activities are carried out in manufacturing process provides a behavior perspective about the execution of the activities.

- In this stage, UML sequence diagrams are used show which message transfers take place and how communication evolves among the different actors involved to carry out each activity.

- The generic sequence diagrams defined in this step describe all information exchange between level 3 and 4 of the company, taking into account the activities and objects previously identified in generic IDEF-0 diagrams.

Designing MES Specific Model

Specific functional model: ***adaptation of the generic IDEF models using company specific requirements***

•The first step is to define the (company) specific IDEF0, taking into consideration the generic IDEF0 model of the ANSI/ISA-95 developed earlier.

•Before making the “To Be” company specific IDEF0, it is proposed to form a multidisciplinary team to firstly develop a current (As-Is) functional model (IDEF0) of the company. Using this model and taking into account the desired final state that is expected to reach with this integration project, the specific IDEF0 (functional) model (To-Be) is defined.

Designing MES Specific Model

Specific sequence diagram: ***adaptation of the generic sequence diagrams using company specific workflows***

•The second step is to adapt the generic UML sequence diagrams to the specific company's situation.

•The integration team define the current sequence model (As-Is) taking into consideration the As-Is IDEF0 model and the collected information about the flow of current information exchange.

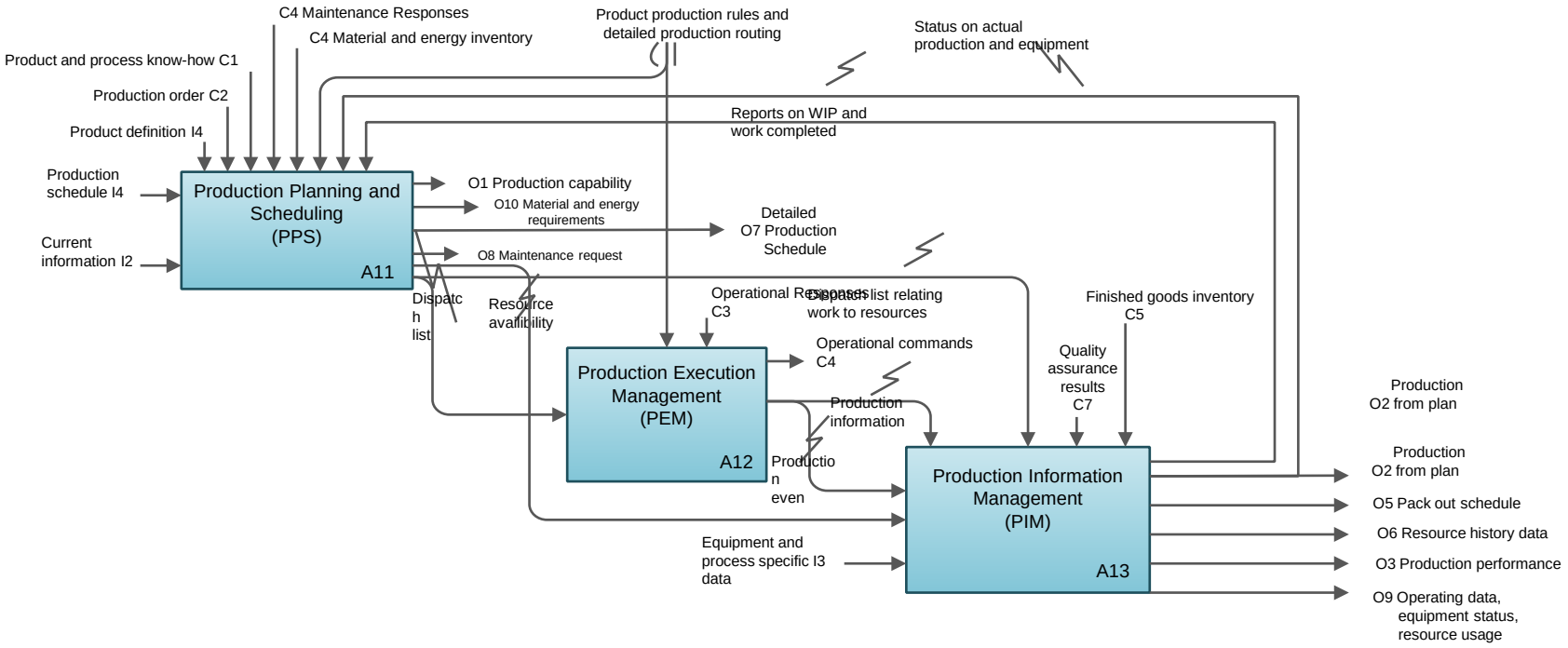
•Using these sequence diagrams and taking into consideration the specific IDEF0 (To-Be) model as a reference, specific UML sequence diagrams (To-Be) are modeled in order to define clearly the information exchanges that is desired to occur within the enterprise.

Case Illustration

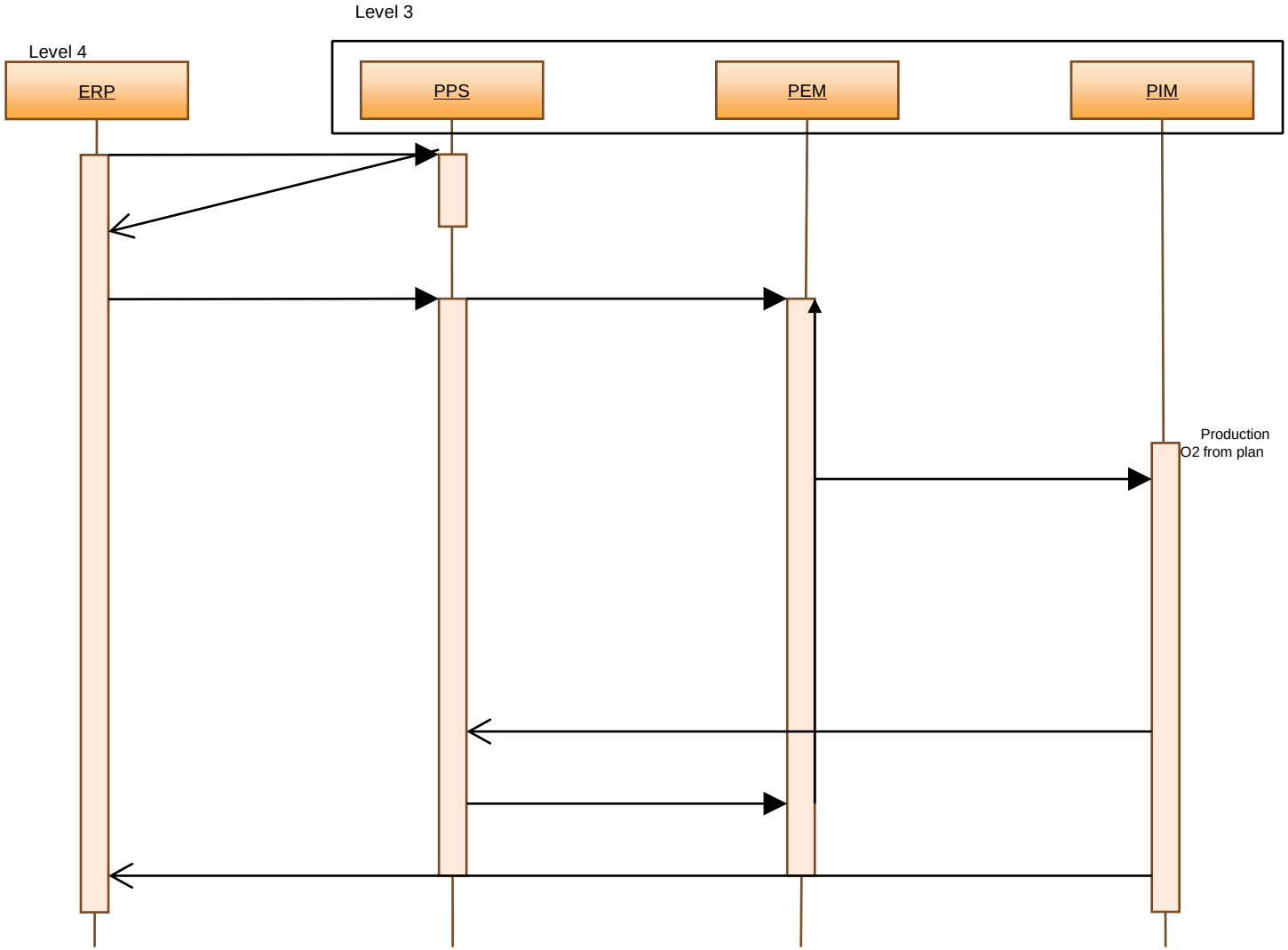
A pilot test is done in a steel manufacturing company in Indonesia The scope of the integration project covers the management of Production Operations Management, Quality Management, and Inventory Management.

In the next part the “Specific Functional Model” and “Specific Sequence Diagram” for Production Operations Management are presented.

(Company) specific functional model for Production Operation Management



IDEF0 Model of Production Operations Management



Sequence UML Model Production Operations Management

Conclusion

The use of ISA-95 reference (standard) facilitates the development of MES and its integration with ERP systems of the company, because ISA-95 provides a unified reference framework, which can be used to define the functional and activity models as well as the sequence diagrams, addressed by the proposed methodology.

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Thank you ...