Architecture description of RFID in supply chain

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Architecture Description of RFID in Supply Chain

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Abstract

As the economy becomes global, supply chain management is becoming an important element in many businesses, and supply chain stakeholders put a lot of effort on reducing cost, shortening lead time, and improving customers' satisfaction. These demands pull the development of the ICT-reliant technologies, such as: RFID technology and ERP systems, which are used to improve the efficiency and performance of the supply chain. From the literature study, it appeared that there is little attention being paid to give a reference model of how the RFID technology can be implemented into supply chain systems and integrated with ERP system to enhance the data management. Such reference model can give intuitive impression and guidance to the users and other stakeholders. This master project focuses on building the Business Operation Model and reveals the benefit and obstacles of RFID deployment by model-driven development in a multi-level perspective.

Keywords

RFID technology, ERP systems, Multi-level perspectives, Model-driven development

1. Introduction

There are two ICT-reliant technologies which can significantly improve the efficiency and performance of the supply chain system – RFID & ERP.

Radio-Frequency Identification (RFID) is a generic term of technology which uses radio waves to automatically identify objects. RFID can be used in a broad area, such as: asset management, inventory control, regulatory compliance and finance and banking industry, etc (Kumar, 2007). When implementing this technology into supply chains, it can bring great benefits to stakeholders. The significant advantage of all kinds of RFID systems is the non-contact and non-line-of-sight nature of the technology, and other advantages such as: reducing cost, tracking products and optimizing inventory level (Kelly and Erickson, 2005). However, the limitations of it cannot be neglected, such as: tag readability, data ownership and sharing, standards, and security, etc (Kelly and Erickson, 2005).

"In one sentence, ERP is a combination of business management practice and technology, where Information Technology integrates with your company's core business processes to enable the achievement of specific business objectives (ITtoolbox Popular Q&A Team, 2002)." In today's global competitive business environment, companies, which use ERP system as a strategic tool, can lower the total costs in the supply chain. The integrated ERP system can help companies achieve the efficient and effective use of their assets and provide customers with the visibility they need, and can provide a great opportunity for many companies to gain critical insight and competitive advantages (Caruso et al. 2007).

Two research questions will be solved in this master project. First, as there are many companies that will adopt RFID technology, the problems will come up during the period of RFID project implementation, and I will define several main integration problems and try to find the solution of them; second, the way of how RFID technology can be implemented by organizations, and be used and evolved within organizations and alliances is another point in my project; third, in this final project, I will try to build the Business Operation Model for RFID-enabled supply chains, by using Model-Driven Development Methodology in Multi-level perspectives.

In Chapter 2, Balanced Scorecard and Project Performance Scorecard are used to analyze the RFID project in Supply Chain System and Change System; Chapter 3 its main focus is on analysis and diagnosis of data management of RFID technology, which is the core part of RFID systems; In Chapter 4 an architecture description of RFID deployment by model-driven development in a multi-level perspective will be given. This part is based on the Dr. J.B.M. (Jan) Goossenaerts work of "Architecture Descriptions for Society Wide Information Systems"; Chapter 5 contains a case study of how RFID technology can help the organization to gain profit and competitive advantages; Chapter 6 is the conclusion of this Master Project.

2. The problem in integrating RFID and ERP into Supply Chain

2.1. Introduction of Radio Frequency Identification

The RFID is one of the promising technologies that can be used to complement existing supply chain systems. This technology does not replace existing systems. In fact, it requires that there be an existing infrastructure of systems to provide the foundation upon which it can be installed. Once installed, this technology provides a way to better collect data needed by existing systems. It can provide better ways to share data among systems and to make that data visible and meaningful to people who need it.

2.1.1.*How RFID system works?*

RFID systems include tags, antennas, readers, and software to process the data. The system works thus: the reader sends a radio signal that is received by all tags present in the RF field tuned to that frequency. Tags receive the signal via their antennas and respond by transmitting their stored data. The tag can hold many types of data, including a serial number, configuration instructions, activity history (e.g., date of last maintenance, when the tag passed a specific location, etc.), or even temperature and other data provided by sensors. The transmitters can be placed anywhere that tracking the movement of goods adds value to the commercial process: on containers, pallets, materials handling equipment, cases or even on individual products. The information on tags is read when they pass by an RFID reader, and that movement is captured and managed by the infrastructure. The read/write device receives the tag signal via its antenna, decodes it and transfers the data to the computer system through a cable or wireless connection. In this way, organizations are able to link the physical world to the digital world without any human interaction.

2.1.2.*RFID Implications and Evolving Business Processes*

The following part will list some main fields of RFID implications in the business processes. (Intermec Technologies Corporation, 2004 and Kumar, 2007)

- **Inventory Control:** The main benefit of using RFID in the supply chain is inventory control, especially when the RFID technology can offer the capabilities to collect information and provide visibility. Also, the RFID technology can help companies avoid the theft of items or products.
- **Asset management:** RFID tags can be attached to capital equipment and fixed assets, for automatically tracking the movement and location of tagged assets.
- **Shipping & Receiving:** The same tags used to identify work-in-process or finished goods inventory could also trigger automated shipment tracking applications.

- **Returns & Recall Management:** Unique information can be written into RFID tags, which would enable a highly targeted notification, return operation, and avoid a costly general recall.
- **Finance and Banking Industry:** Some smart cards embedded with RFID chips are used as electronic cash, which provide a new and convenient payment method and real-time market data capture.

2.2. Actors in Supply Chain

The Table 1 and Table 2 list the potential actors in Supply Chain. The list contains two kinds of actors: one is System Actors, which offer certain kind of business services, such as ERP system, RFID technology, etc; another one is Human/Organization Actors, who conduct different business processes and activities. In order to give a clear-cut view and for easy understanding of the model, Figure 1 depicts the actors which will show up in Chapter 4.

System Actor	Description
RFID	Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
ERP	Enterprise Resource Planning systems attempt to integrate several data sources and processes of an organization into a unified system. A typical ERP system will use multiple components of computer software and hardware to achieve the integration. A key ingredient of most ERP systems is the use of a unified database to store data for the various system modules.

Table 1 – System Actors in Supply Chain

Organization Actor	Description
Supplier	Supplier may refer to manufacturer, processor, packager, distributor, wholesaler, dealership, and merchant, etc.. Here, we only regard it as raw material supplier, which is an enterprise or an entity that offers the rough material to manufacturer.
Manufacturer	Manufacturer is an enterprise or entity, who makes use of tools and labor to make things for use or sale. The term manufacturing may refer to a vast range of human activity, from handicraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods on a large scale.
Distributor	A distributor is the intermediary between the manufacturer and customer. After a product is manufactured, it may be warehoused or shipped to the next echelon in the supply chain, typically either a distributor, retailer or customer.
Customer	A person or an enterprise, or an entity that consumes the final

	products that have been produced by manufacturers.
Shipper	Someone who prepares goods for shipment, by packaging, labeling, and arranging for transit, or who coordinates the transport of goods
Carrier	"Carrier" means any person who, in a contract of carriage, undertakes to perform or to procure the performance of transport by rail, road, air, sea, inland waterway or by a combination of such modes.
Consolidator	A consolidator, also known as a bucketshop, is a business that buys tickets in bulk (at deep discounts but with many restrictions) from airlines and resells them to travel agencies. Consolidators are wholesalers and are prohibited (by contract) to deal directly with the public, so these tickets must be obtained through a retailer.
Consignee	In a contract of carriage, the consignee is the person or company to whom the shipment is to be delivered whether by land, sea or air.

Table 2 – Human/Organization Actors in Supply Chain

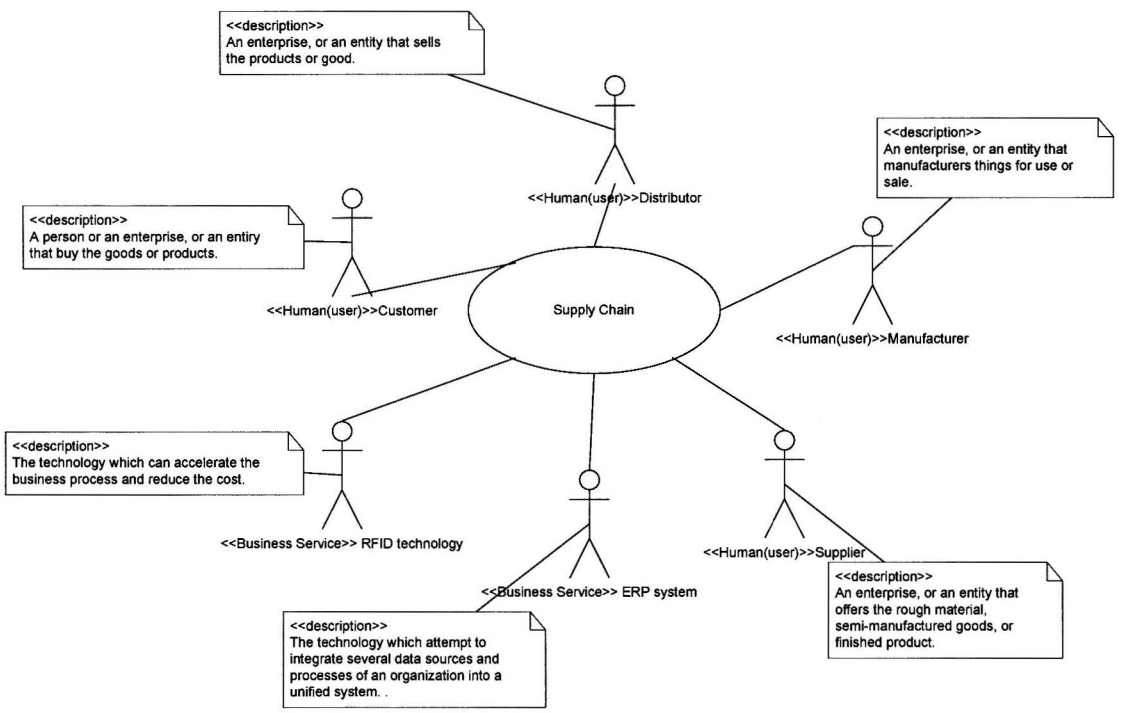

Figure 1– Potential Stakeholders in the Supply Chain

2.3. The Problems of RFID Implementation

When we evaluate the problems of RFID implementation, there are two levels of problems. One is on Macro Level. At this level, we chose to look at Change System and Project; another one is on Meso Level, at this level, the focus is on Supply Chain Work System. For

Macro Level, the Project Performance Scorecard (PPS) will be used to analyze the problems faced in project, and the Balanced Scorecard will be adopted in Meso Level.

2.3.1. *Pre-Analysis of Change System*

Change System is be regarded as the Macro Level/Landscape Level in this thesis, and the Project Performance Scorecard (PPS) is to be employed to measure the performance of Change System before and after the RFID deployment project.

2.3.1.1. Change Management

A common definition used for change management is a set of processes that is employed to ensure that significant changes are implemented in an orderly, controlled and systematic fashion to effect organizational change. Change management is often one of the most significant components of the successful management of a project and must be focused throughout the life of the project (Department of Commerce of Australia, 2002).

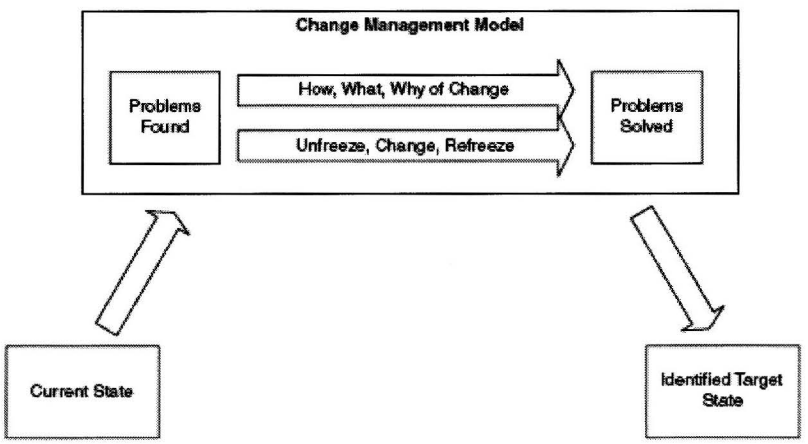

Figure 2 – Generic change management framework

Figure 2 represents a general framework that underpins change management. From the picture, we can see that change is the process moving from current state to identified target state, and change management model provides the supports and guidelines which ensure the successful of the moving process.

Perks and Beveridge (2003) have indicated that change is difficult:

- There is resistance to the unknown.
- People can be cynical about change.
- There is doubt that there is an effective means for conducting change.
- Organizational change can clash with the values of the organization's members.
- Change may conflict with other organizational goals.

2.3.1.2. Project Performance Scorecard (PPS)

Barclay (2008) has indicated that the PPS provides a measurement system that assesses the value and performance of the project throughout the project and product life cycles. It contains six dimensions: stakeholder, project process, quality, innovation and learning, benefit and use perspectives (Figure 4).

- ***Project Process*** **perspective** considers the processes of the project from conception to handover to the client. It acts as a supplement of traditional measurement, and extends more attentions on financial gains, the efficient use of time and risk management.

  A clearly and structured IT project process can help organizations understand the procedures on how to create, receive approval, design, build, run and decommission medium, large and enterprise-wide projects (STS Group, 2004); and a standard process can bring benefits for the launch of the IT project:

  - Apply a standard methodology while running various types of IT projects
  - Provide a consistent message when working with the business community and our partners
  - Indicate the individuals associated with each task related event
  - Provide the management team a clear roadmap for critical milestones
  - Provide multiple references for critical deliverables in a systematic manner
  - Hold the project owners accountable for maintaining scope control during complex projects
  - Provide meeting timetables for the project team members
  - Provide proper notifications on critical timing of deliverables to all departments involved
  - Provide a reference tool for quickly training new project owners

- ***Stakeholder*** **perspective** considers the complex nature of the stakeholders' expectations and objectives. Good understanding of the attitudes of stakeholders can help project executants evaluate what is most important to stakeholders and monitor the objectives of stakeholders.

  There are different kind of Actors in supply chain system, In this master thesis, I use the "Actor" instead of "Stakeholder", because of the different roles the stakeholders act in supply chain system.

- ***Benefit*** **perspective** considers the gains or business value that can be attributable to the project, particularly the soft benefit. Kaplan and Norton (1996a, b) have indicated that organizations primarily concern bottom-line improvement of the company, and this principle also can be used in the Project Performance Scorecard.

  As generally accepted, ICT has been regarded as a technology that can underpin future growth and innovation. It may help efficient firms gain market share, raise

productivity, expand product range, and customize services. Moreover, it can help organizations get a better respond to demand, reduce inventories or help firms integrate activities throughout the value chain (OECD, 2003).

- ***Learning & Innovation*** **perspective** focuses on the knowledge capabilities which can be gathered from the project. It shows that the organizations can get advantages and value creating opportunities for project, and practices can foster knowledge sharing and project learning during the project.

  ICT project helps firms to improve and re-invent business processes and develop new applications, thus effectively enabling innovation in this sector (OECD, 2003), and also, from the ICT project, the employee of the organization can get training and education.

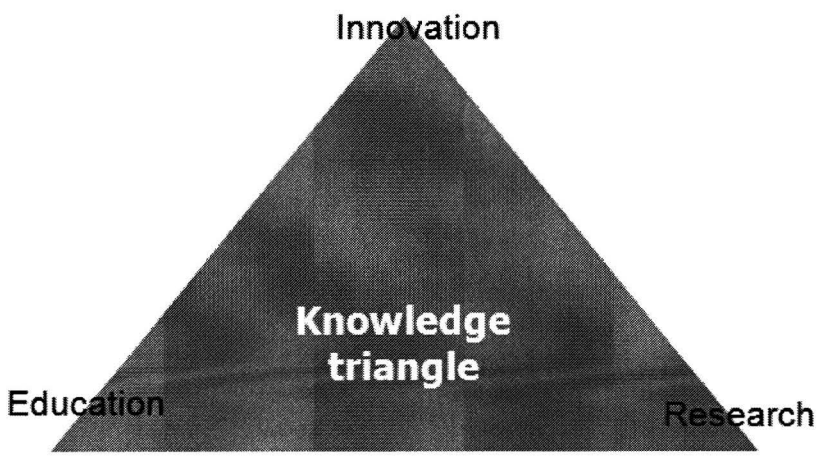

Figure 3 - The Knowledge Triangle: Innovation, Education and Research

- ***Quality*** **perspective** indicates whether the ICT project could meet or exceed stated objectives of project process and outcome. Organizations have different business objectives; requirements of the new project which used for carrying out the objectives should be met. For example, the main concern of organizations in today's global market is cost-effective, and it is one of core factors which can help companies maximize their benefit. In order to achieve this goal, RFID technology is used to improve the supply chain performance.
- ***Use*** **perspective** evaluates the use of the project outcome that is conducting a determination of how the project results are being used, if at all. The quality of the outcome and other factors can give impacts on level of use or attitude towards the outcome.

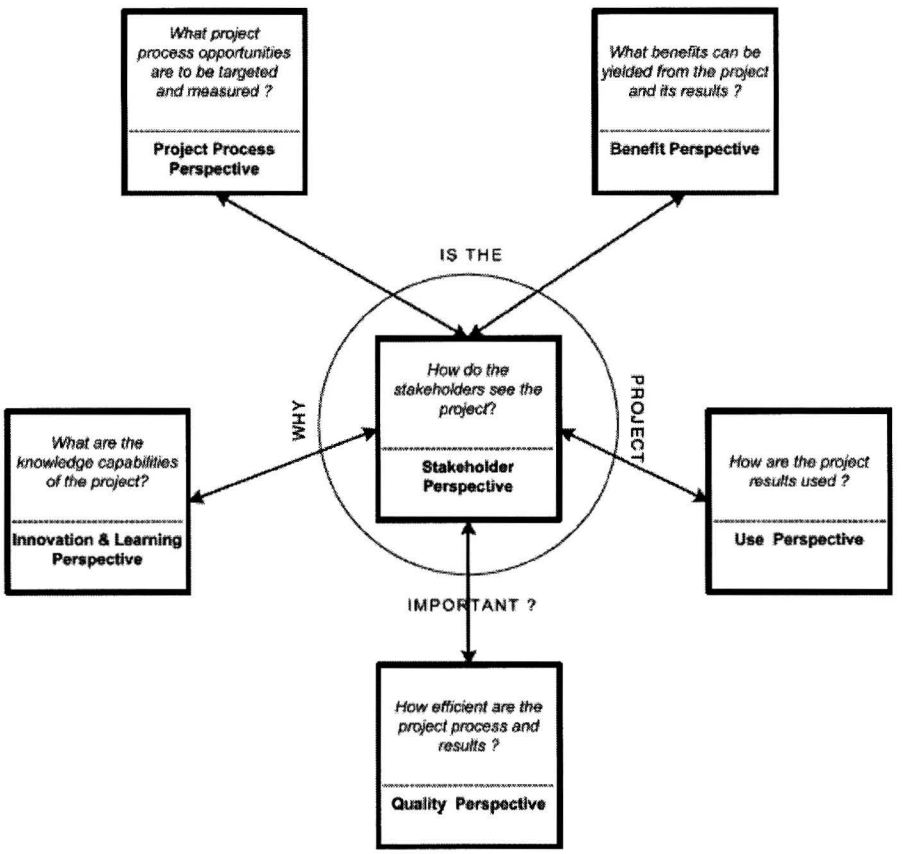

Figure 4 – Project Performance Scorecard

2.3.1.3. Methodology of Project Implementation

Enterprise architecture is a holistic approach, which can add value to organizations by shortening development times, reducing budget overspending, and increased flexibility in the organization as a whole (Fowler, 2003). The Open Group (2002) has defined Enterprise Architecture as: "a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure."

Figure 5 shows the conceptual framework of architecture description. It can apply to different systems and architectures, and explain how the key terms related to each other in a conceptual model for architecture description.

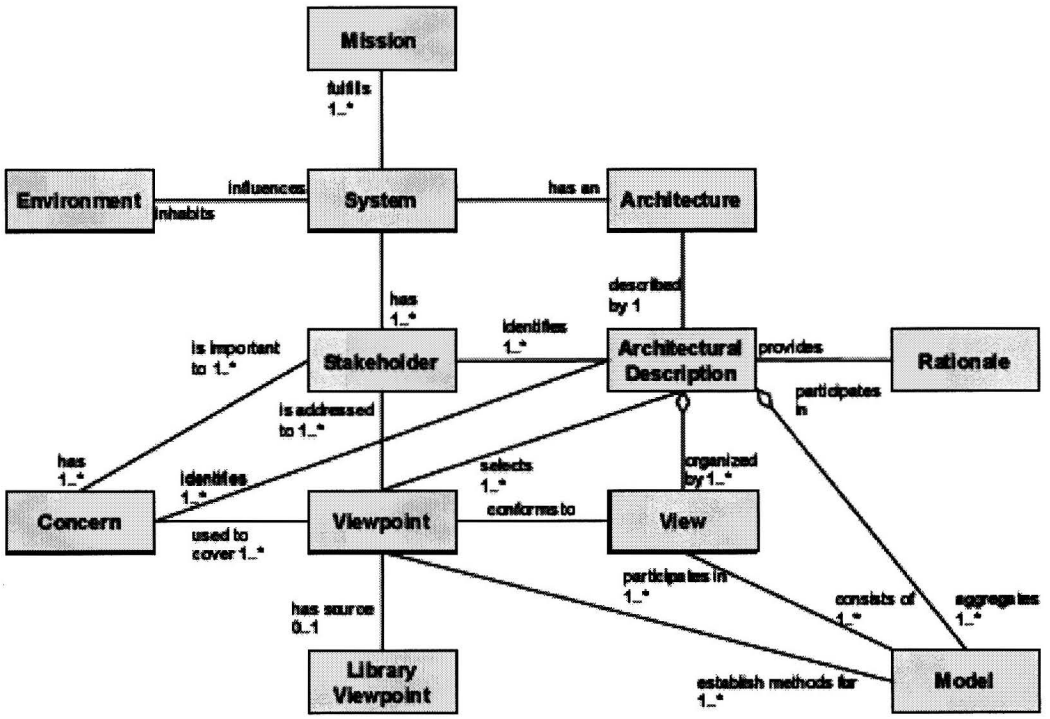

Figure 5 – Conceptual model of architecture description (IEEE Computer Society, 2000)

We adopt Enterprise Architecture to launch such ICT-related project, which promises and assures both technical and transformational advantages. The benefits for the organization are summarized as follows (TOGAF, 2005):

- A more efficient IT operation
  - Lower software development, support, and maintenance costs
  - Increased portability of applications
  - Improved interoperability and easier system and network management
  - A better ability to address critical enterprise-wide issues like security
  - Easier upgrade and exchange of system components
- Better return on existing investment, reduced risk for future investment
  - Reduced complexity in IT infrastructure
  - Maximum return on investment in existing IT infrastructure
  - The flexibility to make, buy, or out-source IT solutions
  - Reduced risk overall in new investment, and the costs of IT ownership
- Faster, simpler, and cheaper procurement
  - Buying decisions are simpler, because the information governing procurement is readily available in a coherent plan.
  - The procurement process is faster - maximizing procurement speed and flexibility without sacrificing architectural coherence.

2.3.1.4. Incremental Information System Development – Model-Driven Development

Elvesaeter et al. (2005) have demonstrated that Model-driven architectures (MDA) focus on design-time aspects of system engineering and it describes "how to develop and utilize (visual) models as an active aid in the analysis, specification, design and implementation phases of an ICT system." In addition, MDA application in enterprise architectures and systems architectures can help model based systems to avoid or reduce the lost of information and to increase the separation of concerns, flexibility and traceability. (Uriarte and Elguezabal, 2006).

The Model-Driven Development includes three parts (Figure 6): *Computation Independent Model (CIM):* A Computation independent model is a view of a system from the computation independent viewpoint; it does not show the details of the structure and processing of the system, but only focuses on the environment of the system, and the requirements for the system. *Platform Independent Model (PIM):* A Platform Independent Model focus on the operation of a system, but not the details of a particular platform; it shows part of the complete specification that does not change from one platform to another, and is suitable for use with a number of different platforms of similar type. *Platform Specific Model (PSM):* A Platform Specific Model combines the specifications in the PIM with the details that specify how that system uses a particular type of platform. "Change interventions in the ICT-reliant enterprise maintaining CIM, PIM and PSM models proceed with "delta models" that articulate changes to the consolidated models in order to meet the new needs or resources of the client." (Goossenaerts, 2004)

In this master project, the COMET methodology is adopted to build the CIM and PIM models of RFID implementation project.

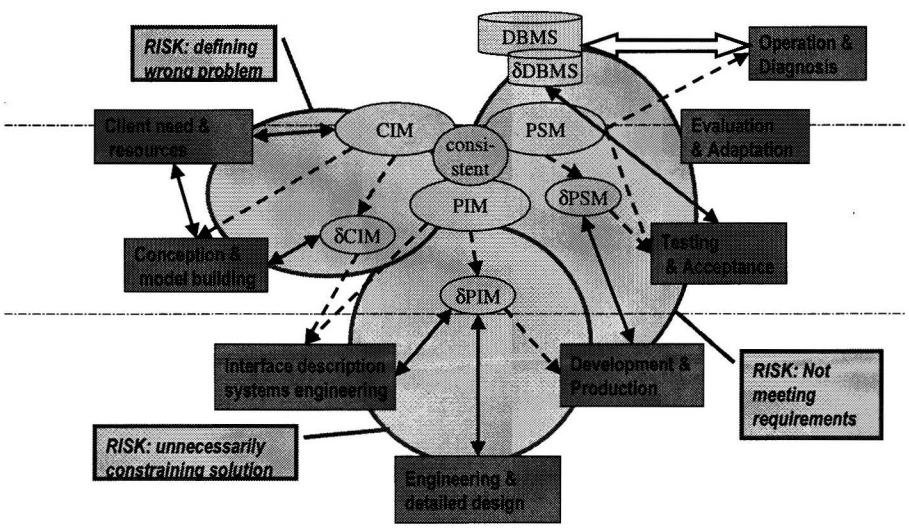

Figure 6 - Project Activities, Models (and Data) and Risks

2.3.1.5. Problems/Challenges Faced in Change Systems (Project)

Before we launch the new project, it is necessary to analyze and identify problems/challenges faced by such project. This can give the overall view of the project/changes to the stakeholders and can help project adopters to reduce the risk, cost and save time for conducting such project. Perks and Beveridge (2003) have pointed out several main problems when adopting a new ICT project:

- ***The Business / Technical Strategy Gulf:*** Most of the organizations do not have a method to incorporate business strategy and technical strategy, which make decision-making and a technology environment out of step with the needs of the business.
- ***The Information Inaccuracy and Integrity Problem:*** Most organizations experience the problem of information inaccuracy and integrity. Common symptoms of this problem are:

  - Customers complain that their details are not being updated correctly.
  - Different figures of the same reconciliation information in different systems.
  - Management information cannot represent the actual state of the business.
  - Incorrect output generated from external sources.

- ***The Security Problem:*** As the growth of the Internet, further security risks faced by organizations quickly became apparent. The changing face of information security threats is an important issue for most organizations which have a mature IT infrastructure.
- ***The Cost Problem:*** Another critical problem of ICT-related project is cost. It contains process cost, new investment cost, maintenance/upgrading cost, and procurement and contract process cost. It also include cost of hardware, such as laptops, standard workstations, and data center constructions, etc, and cost of software, such as help desk software, server software, and administrative systems, etc.
- ***The Problem of Incompatible Technologies:*** This is one of the most common problems throughout the organizations. Technical incompatibilities lead to a greater cost of IT in general and technical inefficiencies in the overall business process cause time cost and quality inefficiencies.
- ***Technology Anarchy:*** To some extent, reasoned IT decisions and the stability of the technical environment are affected by factors that are not technically related: technical advocates leave the organization, random technology selection, technology vendors continually remodel their products and services, and distributed decision making.
- ***The Problem with Procurement:*** Procurement processes for IT systems are reinvented for each project. This happens in a number of organizations. As there is limited retained knowledge in the initial part of a project, the approach for describing, assessing, and selecting technical components is often ad hoc and ineffective.

In preliminary stage of a project, the Project Performance Scorecard can be used for pre-analysis of risks. For example, the Cost problem would have negative effect of Benefit perspective and the problem of Business/Technical Strategy Gulf can affect Use perspective.

2.3.2. *Pre-Analysis of Supply Chain Work System*

In this part, the problem analysis will focus on Supply Chain Systems, and Balanced Scorecard will be used as an analytical tool.

2.3.2.1. Balanced Scorecard (BSC)

A widely used method for assessing organizational performance is the Balanced Scorecard (Kaplan and Norton, 1992, 1996). It helps managers to look at the business from four perspectives: Financial perspective, Customer perspective, Internal process perspective and Learning and growth perspective.

- ***Financial*** **perspective** examines if the company's implementation and execution of its strategy are contributing to the bottom-line improvement of the company.
- ***Customer*** **perspective** indicates the importance of customer focus and customer satisfaction to any company. The measurement of customer perspective should contain both value that is delivered to the customer and outcomes.
- ***Internal Process*** **perspective** includes both short-term and long-term objective. "It focuses on activities and key processes required in order for the company to excel at providing the value expected by the customers both productively and efficiently." Measurement of this perspective shows to managers how well their business is running, and whether their products and services meet customer requirement (Arveson, 1998). Operations management, customer management, innovation and regulatory & social are used to identify the measures that correspond to the internal process perspective.
- ***Learning and Growth*** **perspective** can make long-term contribution. It includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement, and it is the foundation of any strategy and focuses on the intangible assets of an organization (Arveson, 1998).

The following picture (Figure 7) is the integration of these four perspectives.

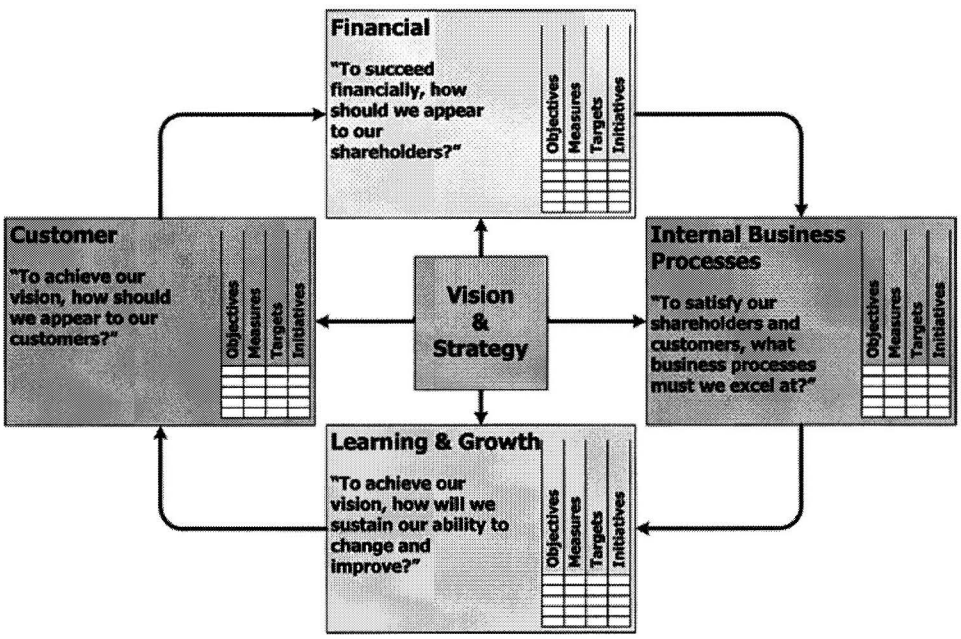

Figure 7 – Balanced Scorecard

2.3.2.2. Problems Faced by Stakeholders in Supply Chain

Although there are some enticing benefits for stakeholders to adopt RFID technology in their business, the concomitant problems which affect RFID applications in supply chain are also well known to the industry and solutions developers. In this part, I will examine some important issues faced by stakeholders today.

- **Cost:** One of the major problems of RFID implementation is the cost of tags. Tag costs are the major variable cost component for RFID, and other related cost components include: software, system integration, process redesign, and organizational impacts are also significant and must be part of the business case (Kumar, 2007).
- **Tag Readability:** Readability depends on tag frequencies and range, reader capabilities and locations, propagation environment, and the type of assets being tagged. Without a 100 percent read rate, the error could be costly depending on the inventory values in the chain (Kumar, 2007).
- **Standards:** There are several technology vendors who make RFID standards, such as International Organization of Standardization (ISO), EPCglobal Inc, European Telecommunications Standards Institute (ETSI) and Federal Communications Commission (FCC), etc (Kumar, 2007). The international standard for RFID systems is necessary, which could improve interoperability, compatibility and exchangeability, and also, an internationally accepted RFID standard will facilitate the growth of the worldwide RFID market (Wu et al., 2006).

- **Business Process Changes:** Business process automation through RFID technology require new work methods and performance measurements for the supply chain, and the new processes and procedures to automate decision-making, and design organizational changes also have to be considered as part of the RFID implementation (Kumar, S. 2007).
- **Privacy and Security:** Because privacy is so important, enterprises can expect this to be an issue for some time, with ultimate resolution through voluntary adherence to industry standards or through involuntary government regulation (Kumar, S. 2007).

2.4. Conclusion

In this chapter, the general problems and challenges of ICT problems have been analyzed. We can see that, the Project Performance Scorecard and Balanced Scorecard is suitable for project measurement. For example, in the preliminary stage of the project, the Project Performance Scorecard can be used for pre-analysis of the risks in project, such as the Cost problems would have negative effect of Benefit perspective and the Business/Technical Strategy Gulf would affect Use perspective, etc.

3. Analysis and Diagnosis of the Data Management of RFID Implementation

ICT is an enabling technology with major impact on the economy and society, and key ingredient to enhance competitiveness. Following the definitions of Alter (2003), RFID-enabled logistic system can be regarded as an ICT-reliant work system, and this chapter will focus on analyzing and diagnosing the core part of RFID project – Data Management, which includes storage, retrieval, manipulation, backup, restart/recovery, security, and associated functions for text, numeric data, and complex data such as documents, graphics, images, audio, and video (Perks and Beveridge, 2003).

3.1. Problem Analysis and Diagnosis in Change System

The EA-enabled project (RFID) can help to improve supply chain performance and efficiency, increase information accessibility, promote good governance, transparency, and accountability, reduce cost of changes. Before implementing an EA-enabled project it is indispensable to set project requirements and analyze problems and challenges that will be faced by the project team.

3.1.1.*Project Requirements*

Project requirement is one of the most important parts of the project. Incorrect, inaccurate, or excessive definition of requirements would cause schedule delays, wasted resources, or customer dissatisfaction. When we talk about the project requirements, it should contain the following basic points (Chapman, 1997):

- Examine the Business Need or Opportunity
- Write a Clear Statement of Project Objectives
- Know the Difference Between Wants and Needs
- Negotiate the Requirements Definition Interactively with the Customer
- Conduct a Thorough and Comprehensive Analysis
- Document the Results Unambiguously in Sufficient Detail
- Put the Requirements Document under Version Control

For IT project itself, there are several requirements which have to be met in order to achieve the business goal:

- *Cost.* The cost can be viewed as the first priority concern when organization plans to implement a project. These costs may be shared among several ICT service management processes and should be afforded by the organization. The major

categories of costs include: personnel costs, software costs and hardware costs. (Anticlue.Net, 2007):

- *Standards*. As there is no uniform standard in the world, when implement an ICT project, selecting the same standards between partners of project is very important. Without the same standards, the objective of interoperation cannot be achieved.
- *Technology Compatibility*. Incompatibilities between different technologies are regarded as one of the critical obstacle in ICT project. such as in many cases, the EPC cannot be recognized by some ERP systems, this can cause some problems, for example: losing interoperability, and reducing the system efficiency, etc.
- *Quality*. The main concern of quality perspective in ICT project is on technical domain. For example, if it is easy to maintain the software and hardware deployed in the project; if the usage of software and hardware is steady; and if it is secure enough to protect users' privacy, etc.

3.1.2. *Challenges Faced in Projects*

For the problem identification, the vicious circle can give the general view of the links between each problem, even if it seems some of the problems have no relationship.

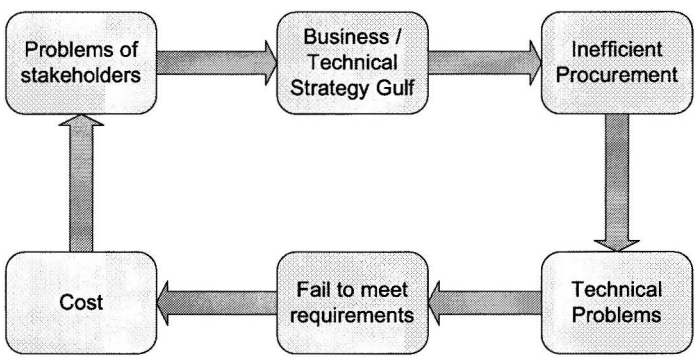

Figure 8 – Vicious circle of IT project

The Figure 8 shows how problems/challenges of IT projects link to each other. Most of the companies cannot make the solution to incorporate the *Business Strategy* and *Technical Strategy*, the business strategy decision-making would be out of step with technology environment; this can cause the problem of *Inefficient Procurement*. As the gulf existed between the business and technical strategy and the limited knowledge in the initial part of a project, the procurement of IT systems could be ineffective and inaccuracy, this will give rise to some *Technical Problems*, for example, the company will choose incompatible technologies that block automatic business process. With other technical problems, such as different standards and lower security, etc, the business requirements and targets cannot be met, and the companies will pay the "*Cost*" of it. Although there still are different kinds of other cost-drivers in the business processes, such as: costs of technology, training cost, and labor cost, etc, what is in focus here is low or even no ROI. After failing to meet the business

objectives, the stakeholders would lose faith and confidence of such project and some of technical advocates and the investor would leave the organization, this will result in dramatic technology changes as advocates in new areas are established, and another vicious circle will arise without the consecutive project planning.

3.1.2.1. Integration Challenges

Many organizations have adopted RFID technology as a strategic tool to realizing automatic identification and real-time data capture, and have focused on the point of maximizing the benefits from the investments and migrating to the modern enterprise infrastructure.

In order to achieve such goals, the mechanisms of seamlessly integrating the data captured at various levels in the supply chain with the back-end applications and decision support systems are needed. Also, with the widely used of RFID technology, more and more demands will be made on the integration landscape leading to an increased complexity of business processes.

Figure 9 shows the importance of Integration in an organization against the complexity of the business.

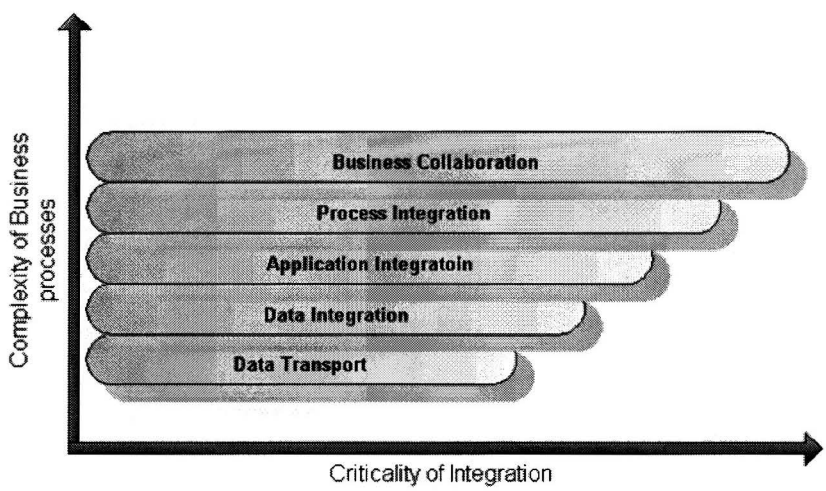

Figure 9 – Integration Importance

The project of implementation of RFID technology will face various integration challenges starting from integrating the readers for identifying the data, to monitoring the data in the ERP and SCM systems, to later manage this data. The following list is the most likely areas where challenges may appear (OECD, 2003):

- *Organizations have incomplete packages and inflexible solutions*
- *Need to integrate new technologies with old ones (legacy)*
- *Diversity in technological standards*
- *Need to incorporate new functions*

- *Incompatibility in business processes*
- *Complex technology with heterogeneous platforms, N-tier distributed computing and the distributed computing and the web*

3.1.2.2. Cost Challenges

The cost of IT in organizations is ineffectively controlled or understood. As discussed before, information integrity issues can lead to poor decision-making, inaccurate billing, or lost customers, which increase the organizations' operational cost. However, not only the degree of IT spending, but also the organization's general attitude (organizational type) toward IT, is the indicator of IT cost. There are three types of organization listed below:

- Type A organizations are always considering the risk of adopting new technology against the rewards of competitive advantage. This kind of organizations will have high IT spending and they expect that a cost-effective IT environment can be discarded in the search for innovation.
- Type B organizations focus on the overall value of adopting technology. They have both innovative and conservative characteristics. These kinds of organizations are inherently value-conscious with respect to IT, and they usually look for an effective return on their technology adoption and will use cost as a driving metric.
- Type C organizations focus on cost-effectiveness as the major driver for IT. Because they are totally cost-conscious, they usually implement technology when it is mature, this can help to minimize chaos and control cost.

3.2. Problem Analysis and Diagnosis in Supply Chain Work System

3.2.1. *RFID Project Requirements*

In order to achieve business objectives, several RFID project requirements should be mentioned before start. The clear and structured requirements can help stakeholders control the process of the project implementation, and evaluate and measure the outcomes.

There are two kinds of requirements for RFID project: the technology itself and the business targets that have to be met.

- ***Cost*:** The cost of RFID technology contains three parts: tag, reader and middleware. The expected price per tag is 5 cent; however, the price below 10 cent is also acceptable. Also, the cost on hiring specialists group is necessary, but in this project, this is not the main concern.
- ***Data filtering and aggregation*:** As RFID technology offers the identification at the instance-level rather than at the class-level, the filtered and aggregated RFID data is needed rather than the raw RFID data (Floerkemeier and Lampe, 2005).

- ***Technology Compatible*:** In most cases, the RFID technology can not be compatible with ERP systems. Currently, some big software vendors have developed ERP systems which are compatible with RFID technology. Such as SAP, who is one of the first software suppliers that joined the EPCglobal.
- ***Security and Privacy*:** Technology vendors and stakeholders put lots of efforts in order to eliminate or at least reduce the impact of this problem, such as: killing the RFID tags, temporarily deactivating RFID tags, and using cryptographer to created new low-power algorithms for RFID tags, etc. (Zois, 2007).

3.2.2. *Problems faced by RFID technology*

Figure 10 indicates the vicious circle of RFID technology. Starting from the *Cost*, though currently, the cost of RFID technology have experienced a huge reduction, but still not reach it's ideal price. The high cost of RFID technology and the technical problems of RFID itself, such as standards, security, and tag readability, etc, make it fail to meet the business requirements, and lead to failure of RFID implementation project.

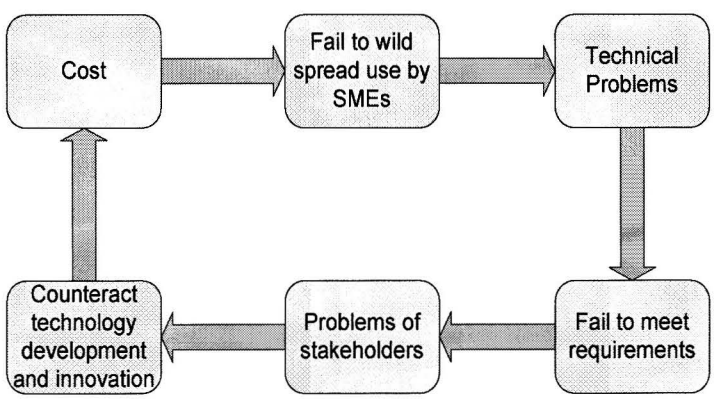

Figure 10 – Vicious Circle of Supply Chain System

Currently, most organizations that implement RFID project will face two problems of data management:

- ***Integration between RFID technology and other enterprise software.***

  Most ERP and warehouse management system (WMS) applications are not specifically designed for RFID data, because of both the data volume and its unique characteristics, such as Electronic Product Code (EPC), which occupies a larger data field than the UPC. New structures for data management should be considered prior to any RFID investment. More importantly, enterprises must determine how they will use the new data to change business processes.

  One effort for overcoming such integration problem between RFID technology and other enterprise software has been done by SAP. SAP has been integrating with

built-in RFID capabilities in its SCM applications since the late 1990s and it was one of the first software suppliers to join the now EPCglobal. The METRO Group and Procter & Gamble are using SAP as part of their RFID technology infrastructure. SAP has also added RFID adaptors to integrate the RFID captured data with SAP Advanced Planning & Optimization (SAP APO), SAP inventory Collaboration Hub, and other SCM Event Management, and mySAP SCM supports RFID-enabled execution scenarios within warehouse and logistics processes (Myerson, 2007).

- ***Data Ownership and Sharing.***

  The benefits of sharing data among multiple parties can be significant, but the willingness of the participants to do so has been a challenge. The success of data sharing in such a supply chain depends significantly on the culture and trust of the enterprises. To remove the fear of data misuse, enforcement of regulations on data ownership in such a supply chain may be a way forward.

3.2.3. *Problems faced by ERP system*

Although ERP systems are a remarkably powerful and pervasive tool, and can offer competitive advantage to enterprises in today's market, stakeholders still face some problems. The ERP system faces many of the same weaknesses that MRP faces because the production modules are simply composed of standard MRP logic. In spite of the success stories on ERP implementation, the costs of implementation, the costs of implementation are typically very high, and firms often become so dependent on consultants for implementation that the pay back takes much longer than anticipated. The databases of the systems are somewhat open, so, the potential security problems must be carefully managed. Though lots of companies have used an ERP implementation as a catalyst for reengineering, they have found that their reengineering efforts are tied to the technology.

3.3. Benefits of Stakeholders in Supply Chain Work System Gained from RFID Project enabled by Multi-level Architecture Descriptions

The Figure 11 shows the target Virtuous Circle of RFID project implementation enabled by enterprise architecture. The causality is obvious. After organizational learning and innovation are strengthened by using Enterprise architecture, the stakeholders are better equiped to implement the RFID technology. This leads to high supply chain performance and cost reduction.

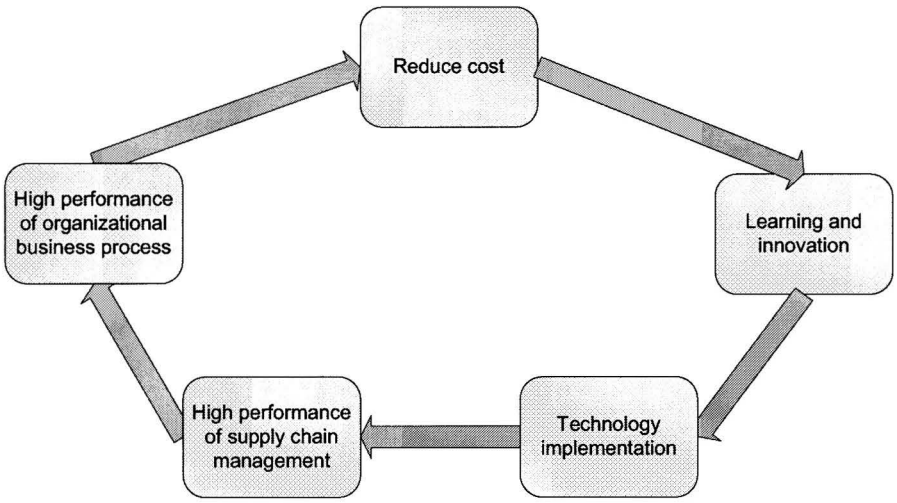

Figure 11 – Virtuous Circle of RFID implementation

Several benefits of RFID are mentioned by Lam and Shankararaman (2007):

- Better forecasts
- On-Shelf Availability
- Automation Proof of Delivery
- Improving Product Security
- Incorporating Shelf Life of Products and Product Self-Management
- Reducing Inventory Levels
- Mass Customization

3.4. Conclusion

Data Management is the core part of RFID implementation. In this chapter, the vicious circle has been used to analyze the common risks of RFID data management. The automatic data collection of RFID technology enables more efficient inventory management and easier product tracking and monitoring, yet there still is a long way to go before the technology can be integrated into business applications, such as ERP systems.

4. Architecture Design

In order to give a full view of RFID deployment efforts, the Business Operation Model is given for the project portfolio in multi-level perspective. "In the Multi-level perspective it is helpful to classify the models as landscape, sector, enterprise and individual models, and to establish refinement, instantiation, and composition relationships among the models at the different levels" (Goossenaerts et al, 2007). The project models are built on Pico, Micro, Meso, and Macro levels. Each level has its own focus.

In Pico level, the tag movement will be tracked. After being tagged, the movement of tag can be regarded as the product movement, so the trace of the tag shows the visible work process in the RFID-enabled system. In Micro level, the focus is on organization itself. In this level, the models of how RFID project can be implemented in the organization are built. In Meso level, the main concern is about the support needed to efficiently deploy RFID in the whole supply chain system. At the Macro level the focus is on how regulatory and standards projects that affect the landscape, which can have a local (regional) to global extent.

4.1. Architecture Description

The advantage of RFID mainly lies in the non-contact and non-line-of-sight capability and the very short response time, which allows enterprises to automate business processes and decision making. Figure 12 shows the layers in software architecture for real-time enterprises through RFID in a supply chain. The lowest layer denotes that the product's data is captured by RFID devices and connected with RFID real-time event architecture, which then communicates with the business applications layer, e.g., enterprise resource planning (ERP).

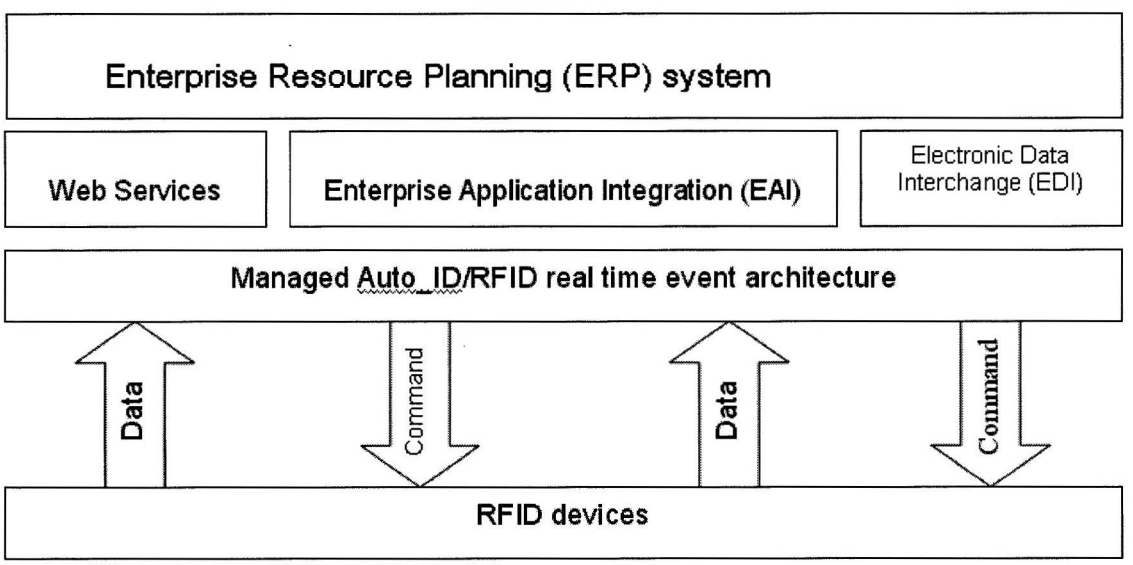

Figure 12 – Real-time enterprises through RFID in a supply chain

In the following Model (Figure 13), some general use cases are shown, and the model gives an overview of RFID project in multi-level perspectives.

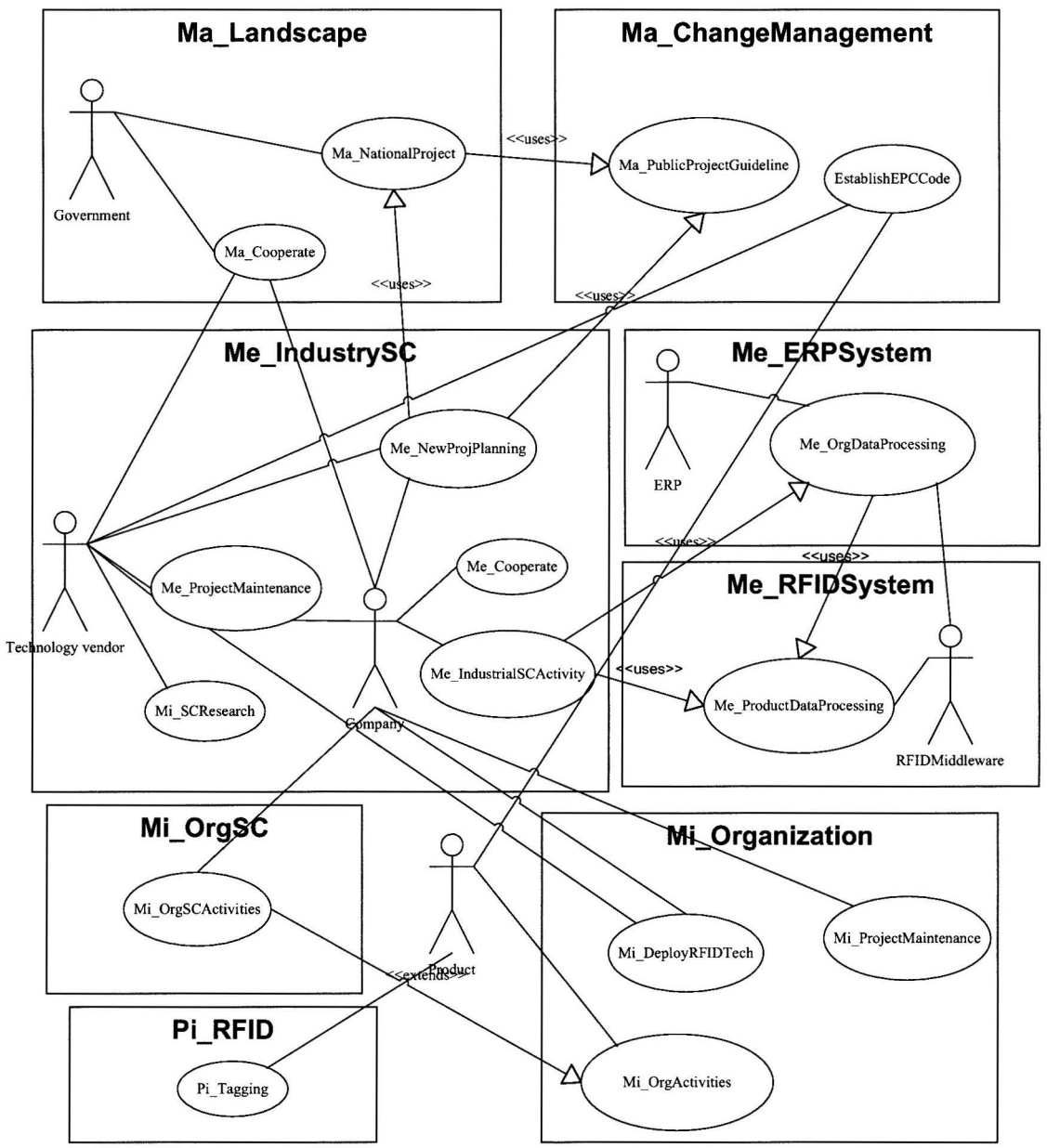

Figure 13 – Overview of System Boundary Model

Use Case	Description
Ma_NationalProject	The national government plans different project for industrial problem solving, such as ICT-reliant project.
Ma_Cooperate	National government and companies in certain industry

	establish consensus on specific project implementation (ICT-reliant project), such as: decide standard, participants, and RFID/ERP products
Ma_PublicProjectGuideline	General descriptions of national project, which can help stakeholders choose an appropriate project.
EstablishEPCCode	Make EPC standards
Me_NewProjPlanning	After problem analyzing, the companies propose to employ a certain project, and make the project plan for it.
Me_ProjectMaintenance	In Meso Level/Supply Chain Level, the "Maintenance" contains two parts: the technology vendors keep the systems (RFID systems and ERP systems) in a good condition and the companies have to keep coordinating with each other.
Me_Cooperate	The supply chain partners establish consensus on RFID project implementation, such as: decide standard, participants, and RFID/ERP products
Me_SCResearch	Research of supply chain activities, which focus on finding and solving existing and potential problems.
Me_IndustrialSCActivity	Include different supply chain activities between supply chain partners.
Me_OrgDataProcessing	Which describe when integrate ERP systems and RFID systems, the organizations can easily access the products' information and make decision.
Me_ProductDataProcessing	Which include how product data (EPC) can be processed through RFID systems.
Mi_OrgSCActivities	Include different supply chain activities in company level.
Mi_DeployRFIDTech	The company decides to use RFID technology after analysis.
Mi_ProjectMaintenance	In Micro level, the project maintenance more focus on training for employees.
Mi_OrgActivities	Which include all organization's business activates, such as accounting, trading, and supply chain management, etc.
Pi_Tagging	Affixing tags on the products.

Table 3 – Use case description of overall system boundary model

4.1.1. *Pico Level*

In Pico Level, the main focus will be on data management process of RFID systems. Figure 22 shows a clear process of EPC code transmission. (1) The information of certain product is written into tags using EPC code. (2) When the products pass a reader, the reader picks up the products' EPC. (3) The reader transmits EPC numbers via Savant server that sends them to a ONS server. (4) ONS uses DNS to match the EPC code to information about the product. (5) RFID middleware software translates EPC into standardized code, which can be used by

other back-end systems, such as EPR systems. (6) Each time an item moves off the shelf, inventory is updated and both the warehouse manager and the manufacturer get the alerts on their screens, these information can help administrators make decision (The use cases and actors in Figure 14 can be find in Pico Level of Appendix A).

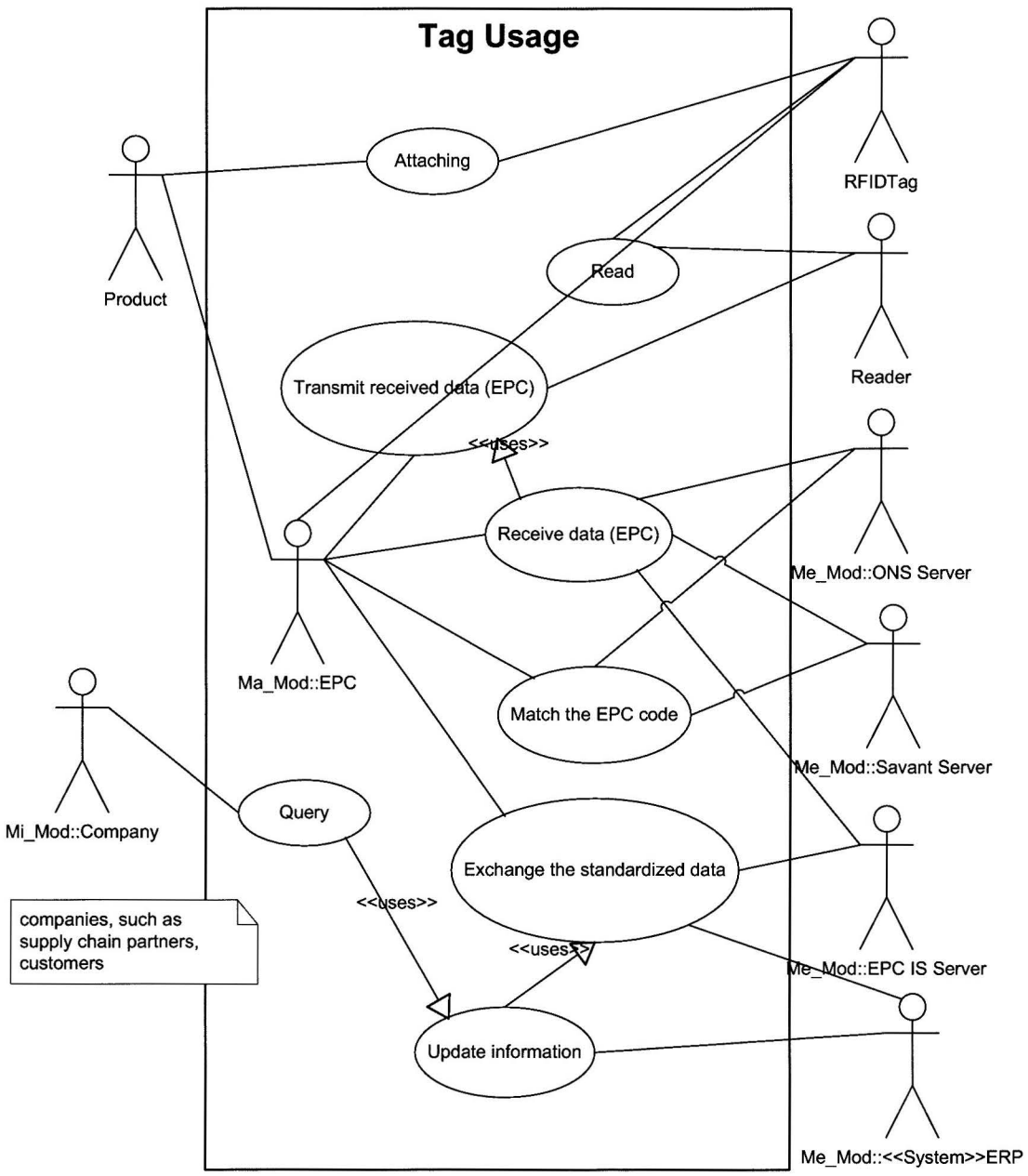

Figure 14 - System Boundary Model (Pico-level)

Use Case	Description	Actors
Transmit Received data (EPC)	The reader transmits the received data.	Reader
Receive data (EPC)	RFID middleware receive the data transmitted from reader.	ONS server, Savant server, EPC IS server
Match the EPC code	The EPC code of product disposed by RFID middleware.	ONS server, Savant server
Exchange the Standardized data	Change the EPC data to standardized data which can be recognized by back-end systems.	EPC IS server, ERP systems
Update information	The ERP systems update to the latest product information, such as: sales, order and transportation, etc, after receiving the data from RFID middleware.	ERP systems
Query	Organizations check the latest status of products.	Organization
Attach	Attaching tags to product	Product, tag
Read	The reader receives the radio wave sent by the tags	Reader, tag

Table 4 - Brief description of Use Case

4.1.2. *Micro Level*

In Micro level, the focus is on the projects that must deploy RFID technology in a company (Company Level). The Micro Level models in Appendix A give a clear description of RFID technology deployment.

Before the project implementation, the administrators of the company need to find out the existing problems in company's supply chain activities (*Define Scope*), analyze problems and challenges (*Manage Risks)*, find out a suitable project (*Define Project*)and, *Define Business goals*; if the certain project is appropriate for company, then the administrators will decide to *Issue Project*. With the help of *Experts Group*, the company finally deploys the RFID technology. In order to keep the projects running in the right way, the organization need to *Analyze Project* regularly. In Micro/Company Level, the Balanced Scorecard is used to analyze the project performance (The use cases and actors in Figure 15 can be find in Micro Level of Appendix A).

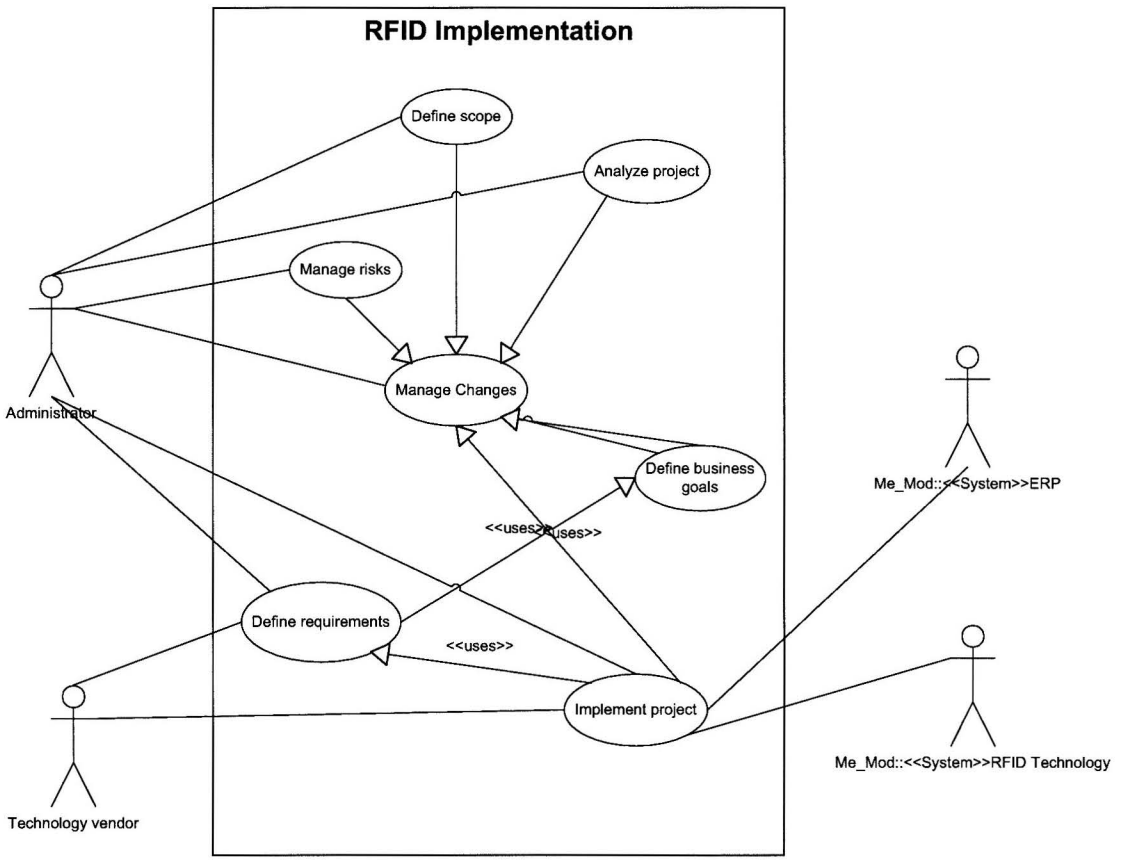

Figure 15 – System Boundary Model (Micro-level)

Use Case	Description	Actors
Define scope	Determine and give a clear introduction of what kind of problems the company faced, and where these problems located.	Administrator
Manage changes	Reduce the negative effect of the risks which will appear during the project implementation.	Administrator, technology vendor
Manage risks	Try to reduce or prevent risk-related cost.	Administrator, technology vendor
Analyze project	Use scorecard to analyze if the project will meet the business goal	Administrator
Define requirements	Define requirements includes define project requirements and define technical requirements	Administrator, technology vendor
Define business goals	Determine the target company want to achieve	Administrator

Implement project	Deploy RFID technology	Administrator, technology vendor

Table 5 – Brief Description of Use Case

4.1.3.*Meso Level*

On a Meso scale, suitable standards must facilitate that RFID can dramatically improve resource utilization in the supply chain. By enabling full visibility into the supply chain, RFID is helping executives adopt demand-pull systems that better match supply with demand and reduce overstocks, markdowns and margin erosion. As forecasts improve, manufacturers are able to more effectively schedule production, reducing costs of changeovers and taking full advantage of economies of scale.

At the Meso level, an industry association, often in cooperation with standards organizations and vendors would produce standards and products in support of projects that are typical for the industry (Markus et al, 2006). The prepared standards and products would support company decision-making concerning the ICT-reliant project.

The models in Meso Level describe the RFID project through supply chain systems (Supply Chain Level). In Meso Level, one of the key factors of RFID project is the cooperation (*Cooperate*) (figure 34) between supply chain partners. In cooperation stage, the supply chain partners need to decide which kind of standards they will need to improve the supply chain performance and efficiency, and decide the responsibilities respectively. Another key point is *Redesign of Inter-organizational Business Processes.* There are two kinds of business processes that need to be redesigned, one is the business processes inside the company, and another one is the business processes outside the company (between supply chain partners). The different data management approach makes it necessary to redesign business processes. Less standard and shared enterprise architecture artefacts will compel each and every company to make its own choices. This will largely increase risks and costs. In Meso Level, the Project Performance Scorecard is employed for analyzing project performance (The use cases and actors in Figure 16 can be find in Meso Level of Appendix A).

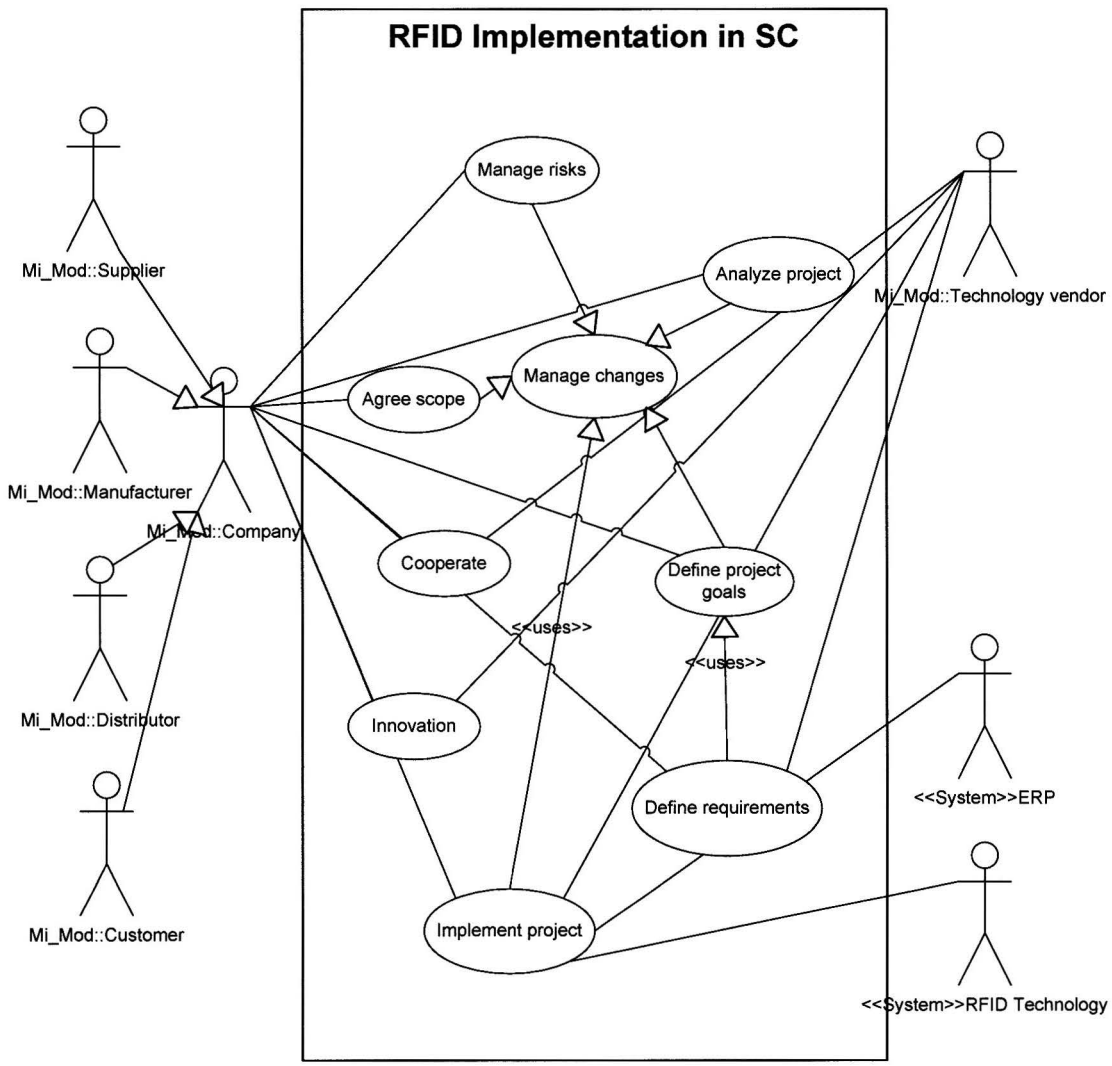

Figure 16 – System Boundary Model (Meso Level)

Use Case	Description	Actors
Manage changes	Ensure that the RFID project is used for efficient and promotion of supply chain performance.	Company (supply chain partner)
Manage risks	Reduce the negative effect of the risk.	Company, technology vendor
Agree scope	Problem identification	Company
Analyze project	Monitor the project implementing processes.	Company
Define business goals	Determine the targets that companies (supply chain partners) want to achieve	Company

Cooperate	Supply chain partners get together to establish consensus of project	Company, technology vendor
Innovation	Innovation includes two parts: business processes reengineering and technology innovation	Company, technology vendor
Define requirements	Define requirements include two part: define project requirements and define technical requirements	Company, technology vendor
Implement project	RFID technology deployment.	Company, technology vendor

Table 6 – Brief description of Use Case

4.1.4. *Macro level*

In Macro level, the stakeholder responsible for the landscape, e.g. the national government acts as a critical role in RFID project. It acts both as sponsor and sustainer. In Macro level, the *Cooperate* part is done by national government, sector organizations grouping companies in a certain industry, and technology vendors. After *Define Scope*, the general problems existing in different industries will be found out, then after *Define Landscape Goal* and *Manage Risks*, different regulations projects, which are appropriate for the landscape, are released, such as RFID regulatory framework addressing privacy and security issues. In this level, technology vendors and industry associations may offer input in consultations that are part of the regulatory process.

The prepared standards and products make it easier to choose, when a company decides to implement an ICT-reliant project. In Macro level, the Project Performance Scorecard is used for analysis of performance of different ICT-reliant projects (The use cases and actors in Figure 17 can be find in Meso Level of Appendix A).

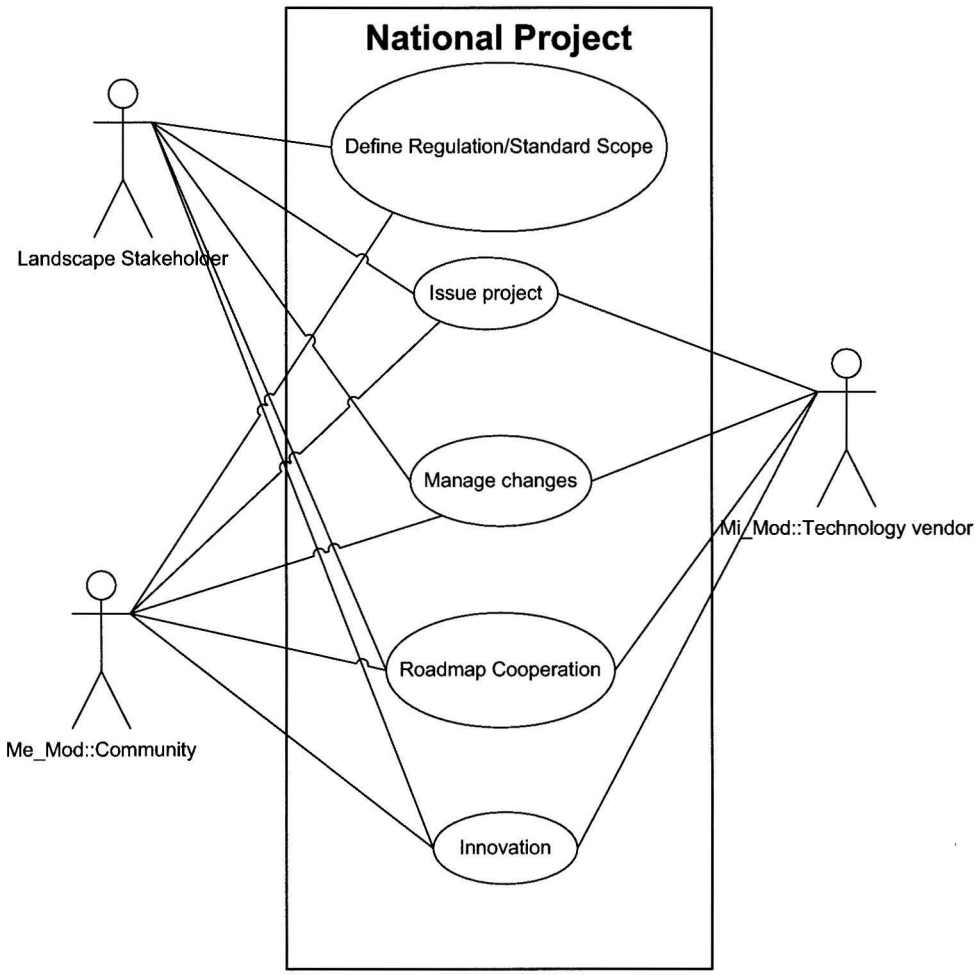

Figure 17 – System Boundary Model (Macro-level)

Use Case	Description	Actors
Manage changes	Ensure that the RFID project is used for efficient and promotion of supply chain performance.	National government, companies, technology vendor
Define Regulation/Standard scope	Problem identification, set different regulations and standard for different ICT-reliant project.	National government, companies, technology vendor
Issue project	Launch ICT project	National government, companies, technology vendor
Roadmap Cooperate	National government, companies in certain industry, and technology vendors work together to establish consensus of what kind of ICT-reliant project to use for a specific industry	National government, companies, technology vendor

Innovation	In National level, the use case of "innovation" more focus on technology innovation	National government, companies, technology vendor

Table 7 – Brief Description of Use Cases

4.2. Conclusion

In this chapter, the Business Operation Models of several RFID implementation projects were built in a multi-level perspective. Figure 18 gives a summary view of the hierarchical structure of RFID implementation projects. Together, these projects are referred to as the RFID Portfolio.

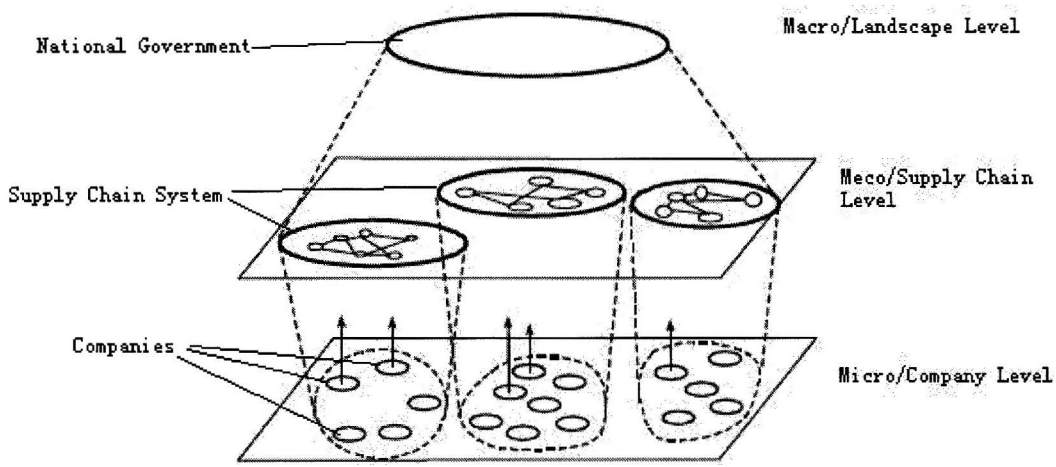

Figure 18 - Hierarchical structure of RFID project

From this chapter, we can see that the multi-level perspective approach allows the allocation and joint addressing of a broad range of questions, from Macro/landscape level to Pico/Tag level, and this approach is helpful for a better holistic understanding of which parts of the RFID portfolio should be conducted at each of the different levels.

5. Implementation

In this part, I will conduct a case study of the Wal-Mart Group to give a clear introduction of how organizations deployed their own RFID project, and what kind of benefit the technology can bring to them. In accordance with Chapter 4, I will show the organizations' RFID project in two levels: Meso level and Micro level. In Meso level (Supply Chain level), the cooperation of RFID project sponsors and their supply chain partners will be demonstrated, in Micro level (Organizational level), the case studies will depict the project sponsors and their technology supporters, and the benefits and advantages they have got from the RFID project.

5.1. Case Study of RFID Implementation in Wal-Mart

5.1.1.*Introduction of Wal-Mart*

Wal-Mart is the largest retail store in the world. According to the Fortune 500 index of the wealthiest and most powerful corporations in the world, Wal-Mart holds the Top first, ranked by its total sales (www.cnn.com). "Wal-Mart provides general merchandise: family apparel, health & beauty aids, household needs, electronics, toys, fabrics, crafts, lawn & garden, jewelry and shoes. Also, the company runs a pharmacy department, Tire & Lube Express, and Photo processing center as well ... Its core retail business can be divided into four retail divisions: Wal-Mart stores, super centers, Sam's Club warehouses and neighborhood markets. Wal-Mart stores and Super centers provide "one-stop family shopping"; combining groceries and general merchandise departments. Sam's Club is the nation's leading members-only warehouse club. Neighborhood Markets offer a convenient shopping experience for customers who need groceries, pharmaceuticals and general merchandise" (Hayden et al., 2002).

5.1.2.*RFID project in Wal-Mart*

- **Macro Level**

  In Macro Level, Wal-Mart employs the EPCglobal EPC standards, but for regulation, as there is no global institute which governs the frequencies used for RFID, and in principle, every country could set its own rules. For example, UHF Tags (868 MHz-928 MHz), cannot be used globally as there is no single global standard. In North America, UHF can be used unlicensed for 902 - 928 MHz, in Europe, UHF is 865.6 - 867.6 MHz, and The North American UHF standard is not accepted in France as it interferes with its military bands.

- **Meso Level**

In order to keep goods in low prices, Wal-Mart has embraced IT project, such as CPFR and RFID technology. Not only Wal-Mart, but its partners have also come into the project, for the splendid future of the technology they believed.

In June, 2003, Wal-Mart Stores Inc. made a decision, to require of its Top 100 suppliers to put RFID tags on shipping crates and pallets by January 2005. It plans to spend $3bn over the next few years on this new inventory tracking (Gilbert, 2003), and expected to deploy nearly 1 billion RFID tags for tracking and identifying items at the individual crate and pallet level. The companies have hoped that this technology can help them to reduce out-of-stock incidents on store shelves; streamline the supply chain and reduce expenses; and give suppliers visibility into shipments.

- **Micro Level**

Wal-Mart has spent about two-thirds of its RFID budget on readers and the installation of them in more than 100 distribution centers and thousands of stores, and the rest of the budget is used for other hardware and software to collect, process and store data the new system generates, and also, the cost of consultants hired also can not be ignored Several major tech companies, including Sun Microsystems, SAP, IBM and Intel, have developed such infrastructures (Gilbert, 2003). In 2005, more than 500 stores and clubs and five distribution centers of the organization lived with RFID (Sullivan, 2005).

After the wide deployment of the technology, a research of Wal-Mart showed that comparing with bar code technology, out of stock items in RFID stores were replaced three times faster than those in barcode stores, 16% reduction in out-of-stock merchandise at Wal-Mart stores equipped with RFID labels using EPC codes, and the 63% more effective in replenishing out-of-stock products than stores not equipped with the technology (Sullivan, 2005). In 2006, Wal-Mart has been speeding up its deployment of the RFID technology, more than 1,000 stores, clubs, and distribution centers have been using RFID (Sullivan, 2005).

Wal-Mart has saved nearly $8.4 billion per year when RFID is fully deployed throughout its supply chain and in stores, and the inventory accuracy has been improved by 13% compared with stores that did not implement the technology (Gaudin, 2008). The success of RFID implementation gave Wal-Mart more confident in pursuing this technology.

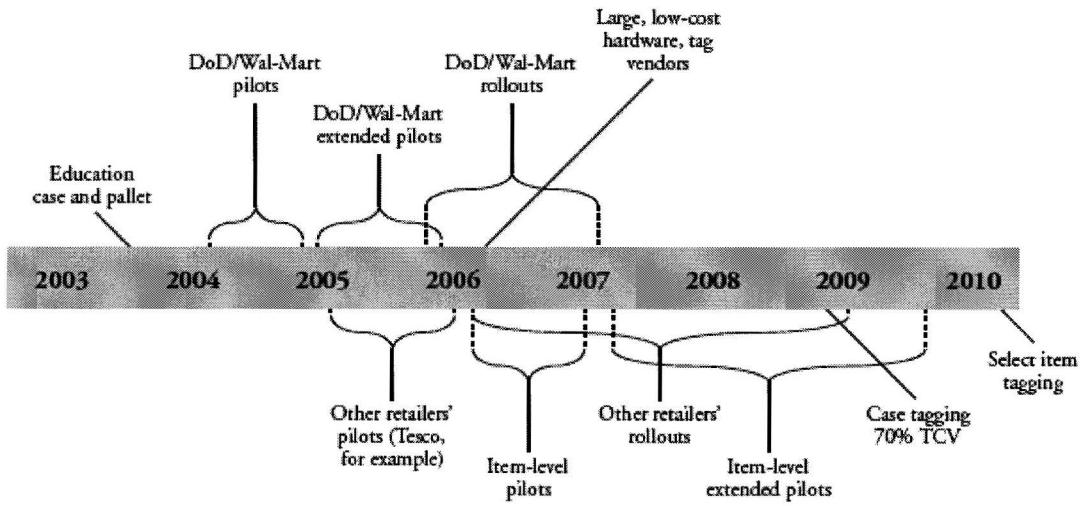

Figure 19 - **Timeline for RFID/EPC (A.T.Kearney)**

5.1.3. *Problems and Analysis*

The previous part shows multi-level of Wal-Mart's RFID project. Though it is obvious that Wal-Mart gains lots of benefits from such project, there are still some sorts of problems at different levels. I will analyze these problems and propose a solution by using the architecture design of Chapter 4.

- **Macro Level**

  The problem that exists at the Macro level is the lack of global standards and regulations as mentioned before. In order to overcome such problem, the National governments need to collect feedbacks from companies in certain industry, and find out existing problems (*Define Scope*), then after *Cooperation*, the industry goals (*Define Industry goals*) and project requirements (*Define Project Requirements*) are released, which is the fundamental of technical requirements (*Define Technical Requirements*). For the same project but new requirements, the technology vendors would do *Innovation*, which make sure that the project could help stakeholders achieve their business goals.

- **Meso Level**

  In Meso level, Wal-Mart and its supply chain partners have implemented RFID for years, though the advantages of RFID technology are obvious, and Wal-Mart has gained much benefit from it, the company still faces problems (Duvall et al., 2007), for example, not all Wal-Mart's business partners embraced the technology (Preston,

2007), and the business processes need to be continually optimized (Palmer, 2004), etc.

In Meso/Supply Chain Level, the Wal-Mart's RFID project does not go smoothly; the biggest problem is not all Wal-Mart's business partners that implemented the technology, though they accepted that the RFID is the future solution of supply chain activity improvement. Some partners complain that though Wal-Mart saw the benefits, but gave its suppliers no guidance and no support. Also, they claimed that Wal-Mart still have some problems on its own distributions system, for instance, it would have to have two lines of readers; one for bar codes and one for RFID. This can give cushion period for some of its suppliers. We can regard these problems as lack of interoperability.

In order to find out the solutions of such problems, the models in Meso Level of architecture design (Appendix A: Meso level) can be used. As the sponsor of RFID project in its industry (industry leader), Wal-Mart could do better in identifying typical (potential) ICT-reliant projects for its supplier base, with for each project *Defined Scopes*, which includes problem identification. It could also share expected versions of these projects with its supply chain partners, etc. In *Cooperation* stage, several things need to be done: making consensus among business partners, and analyzing potential ICT-reliant projects, etc. Then, after clear business goals have been defined (*Define Business Goals*), and manage risks of each potential ICT-reliant project (*Manage Risk*), a specific project is chosen (*Issue Project*). In *Redesign Business Processes* stage, the core mission is to make sure that the new ICT project can help companies improve their business performance, and enhance interoperability among companies and integration of business processes. For instance, the CPFR technology could enhance supply chain integration by supporting and assisting joint practices. After requirements released and with the help from technology vendors (hardware vendors, software vendors and consultancy), the standards and regulations are decided, certain technology products are selected, and then technology vendors help companies deploy the products respectively in Micro Level. Also, as the sponsor, it is important for Wal-Mart to share its successful experience with its business partners, if necessary, offering support directly. In Meso Level, Project Performance Scorecard is used for analyzing performance.

- **Pico Level**

The biggest problem in Pico Level is the cost of technology, especially the cost of tags(RFID tags, RFID readers, RFID middleware and other back-end systems, such as ERP systems). To some extent, this is the crucial factor of RFID project. If the stakeholders feel that the return of investment on RFID technology cannot meet their expectations, or even become a burden of the company, then, no RFID project will be launched.

Unfortunately, the architecture design can do nothing for this problem. The architecture design acts as an interface between business strategy and ICT technology, but for technology itself, the technology vendors (specialists, hardware vendors, and software vendors, etc.) have a critical role in technology development.

Currently, the Wal-Mart RFID project in Micro/Company Level goes well, so it did not show up in this part. If there are some problems, the company can follow the procedures in Micro Level in Appendix A. For company itself, one thing has to be bear in mind: individually business activities can not break up the interoperability and business processes integration among companies in the same supply chain system. For example, if Company X decide to use a ERP systems, which is different with its business partners, this would reduce the interoperability of whole supply chain system.

5.2. Conclusion of Case Study

The case study gives the introduction and problem analysis of RFID project of Wal-Mart. By problem analysis part, we can see that, the multi-level architecture design can help organizations solve problems in strategic aspect, and give instructions of how these problems can be solved.

From what we discussed before, we can define several benefits of architecture design:

- The architecture design can simplify the company's decision making of ICT-reliant project, and accelerate the implementation of selected project. It clarifies the core business process, target and strategy of the company, and link them with certain ICT-reliant projects. This can also reduce the system diversity.
- The architecture design captures the company's core mission (improve supply chain performance and efficiency), and serves as the interface between the needs of company and ICT-reliant solutions that facilitate these needs.
- From the case studies, we can see that the multi-level architecture positions interoperability and integration problems. The stakeholders have clear view of their position, tasks and responsibilities, and also, it enables stakeholders easily manage changes (such as design new systems and extend existing systems, etc.), because of pre-designed reference architectures.

Though Multi-Level architecture design can give a holistic and strategic way to companies for their business problems, and help them increase interoperability, it can do nothing for some bottleneck factors, such as technical problems.

Let's get back to Figure 10, we can see that the cost is the start and the end point in vicious cycle, what we can do for this? We can only wait for the development of technology, which would reduce the cost of such system. If the cost remains high and unacceptable, widely spread of RFID technology can not come true, and the target of improvement of supply chain system performance can not be achieved.

6. Conclusion

In this master project, two research questions have been discussed. One is the problem analysis and diagnosis of the RFID implementation project; another is design of Business Operation Models of such project in multi-level perspectives.

From analysis and diagnosis parts, the methodology and risks of project implementation were introduced, from which, we can see that although the RFID technology has been regarded as an enabling technology which can help supply chain stakeholders reduce inventory level, improve interoperability, and enhance supply chain transparency, it still faces some problems which make it hard to achieve wide deployment. Two critical problems are cost and data management (Chapter 3), to a great extent, these problems can only be solved by technology development.

In design part, the Business Operation Models of RFID project was built in multi-level perspective, which gave a holistic view of implementation processes of RFID project. From which, we can get the conclusion that the success of RFID project needs the support of national government or other landscape stakeholders, the cooperation of companies (supply chain partners or industry associations), the initiative of company itself, and also, the technology vendors have an important role in such project. Regulations and standards, technical support, and technology development, all are responsibilities that someone must shoulder.

Also, from the case study, we can conclude that it is valuable to do architecture design before project implementation. It helps project stakeholders to easily define their own position and responsibilities, and improve interoperability and integration of business activities.

All in all, as an approbatory promising technology, RFID brings huge benefits and competitive advantages to users, it has been regarded as a single most significant enabling technology to impact supply chain execution in 21 century, and worthwhile for organizations to deployment. Macro and Meso level architecture descriptions of RFID implementation projects would support the pro-active addressing of knowledge and cost factors in RFID projects as these must be performed by many companies.

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Appendix A: Multi-level Models and Use Case Descriptions

1. Pico Level

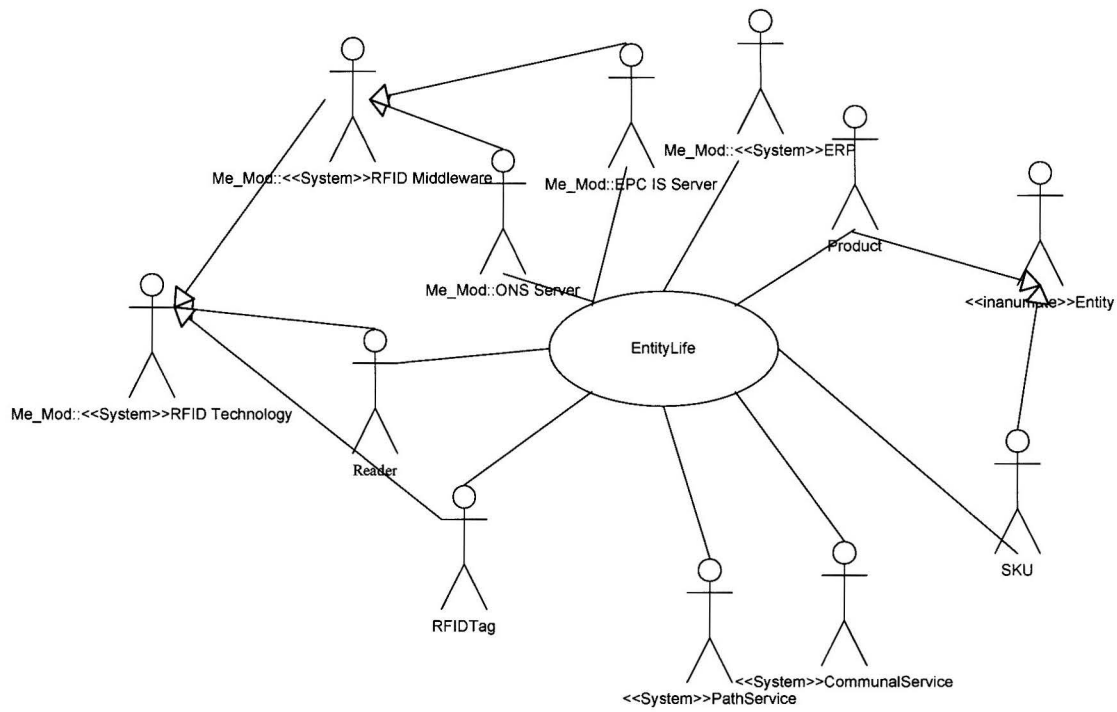

Figure 20 – Context Statement of Pico Level

Actor	Description
RFIDTechnology	Radio Frequency Identification Technology, which contains three parts: tag, reader, and middleware.
RFIDTag	RFID tags come in three general varieties: passive, active, or semi-passive. There are three different kinds of RFID tags based on their attachment with identified objects, i.e. attachable, implantable and insertion tags.
Reader	An RFID reader typically contains a module (transmitter and receiver), a control unit and a coupling element (antenna). The reader has three main functions: energizing, demodulating and decoding.
RFIDMiddleware	RFID middleware applies filtering, formatting or logic to tag data captured by a reader so the data can be processed by a software application.
EPC IS server	EPC IS server is to enable disparate applications to leverage Electronic Product Code (EPC) data via EPC-related data sharing,

	both within and across enterprises.
ONS server	ONS server is a mechanism that leverages Domain Name System (DNS) to discover information about a product and related services from the Electronic Product Code (EPC).
EPC	The Electronic Product Code is a set of digits intended to complement barcodes like the Universal Product Code. An EPC is segmented, with digits that identify the manufacturer, the product category and the individual item.
SKU	A Stock Keeping Unit is a unique identifier for each distinct product and services that can be ordered from a supplier. Usage of the SKU system is rooted in data management, enabling the merchant to systematically track their inventory, such as in warehouses and retail outlets.
ERP	ERP is an enterprise-wide information system designed to coordinate all the resources, information, and activities needed to complete business processes such as order fulfillment or billing.
CommunalService	The CommunalService describes the way of how product data go through different supply chain application systems.
PathService	The PathService describes the way of how tags go through supply chain system.

Table 8 – Description of Use Cases in Pico level

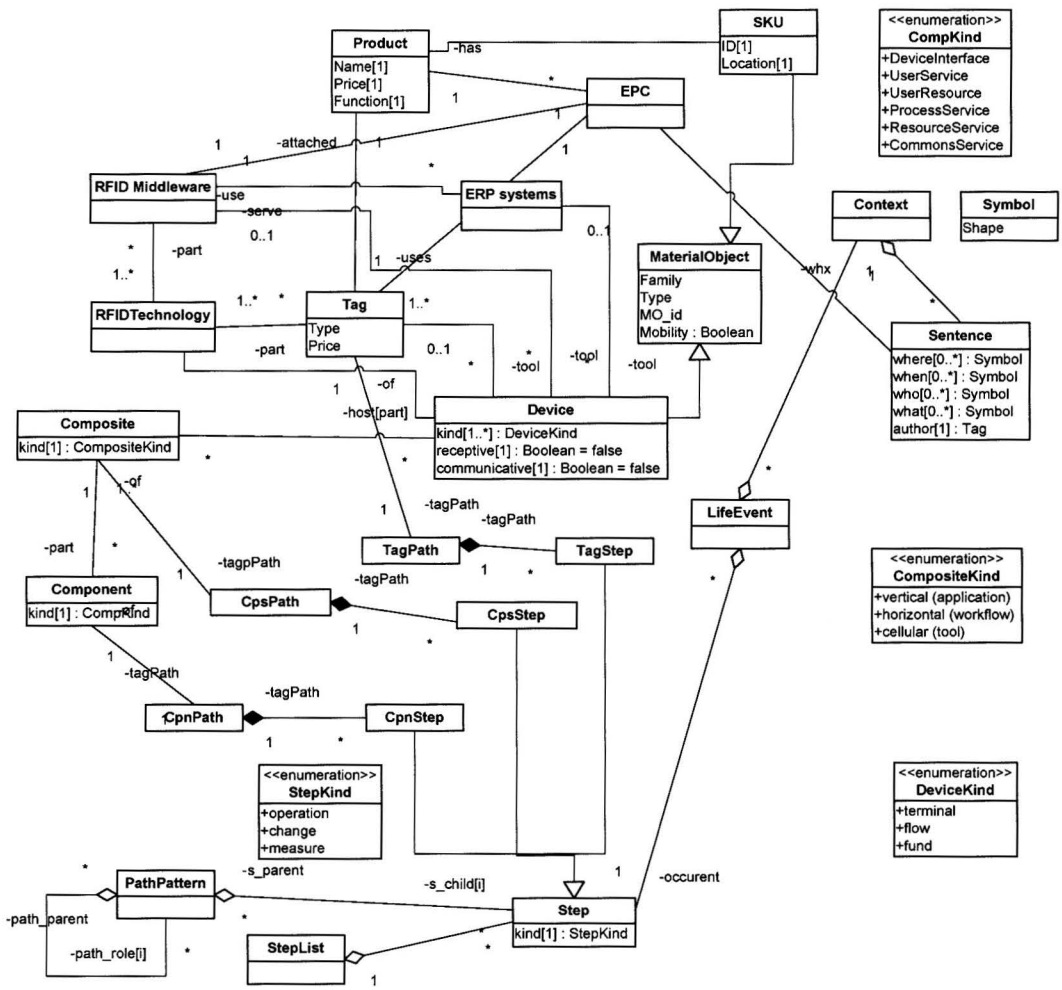

Figure 21 – Resource model in Pico Level

Entity	Description
TagPath	A sequence of steps in which the Tag has participated.
MaterialObject	The object which is perceptible to the sense of vision or touch
Device	The technique or means which is used to serve a particular purpose, such as a machine or software used to perform one or more relatively tasks.
Composite	A composition of components
CpsPath	A sequence of steps that the composite has gone through.
CpsStep	The Composite Step is used to denote the ExtendedStep in COMET. A Composite Step is a Step in which the intermediate states are of interest to the business, and may have to be remembered. This may be either because there are business reasons for such interest, or because other factors, including technology, require that the business be concerned.
Component	A component is an object having a graphical representation that can

	be displayed on the screen and that can interact with the user.
CpnPath	A sequence of steps that the component has gone through.
CpnStep	The ComponentStep is used to denote the ImmediateStep in COMET. A Component Step is a Step that is required to complete as soon as possible, and whose intermediate states are of no concern to the business. It is performed autonomously, with no intervention from a human
Step	A step is something that happens or is done within a process that contributes toward the achievement of the goal of the process. The resource performing the step may itself be modeled as a community and the step may be considered as a process of that community and, as such, be decomposed into steps.

Table 9 – Entity Description

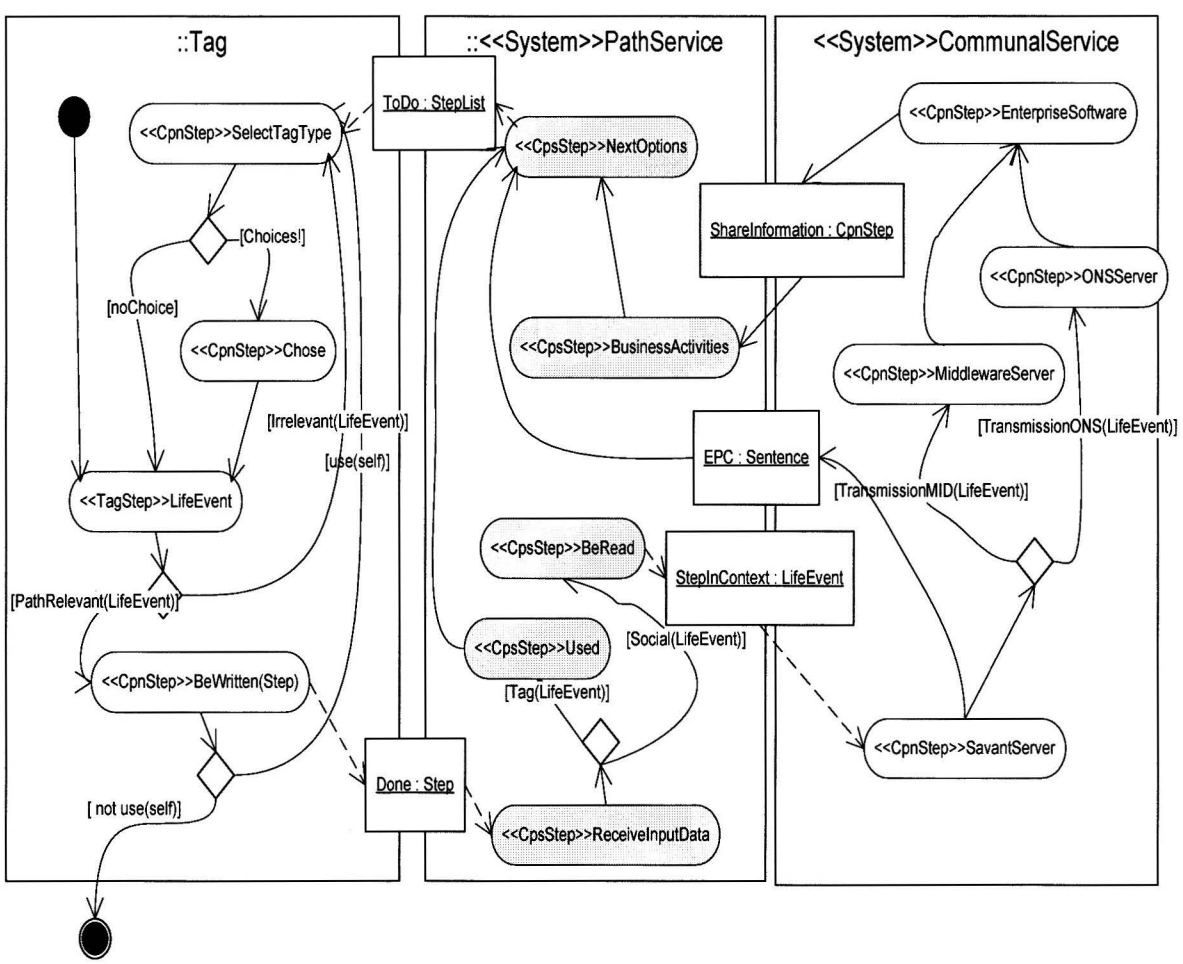

Figure 22 – Tag Lifecycle

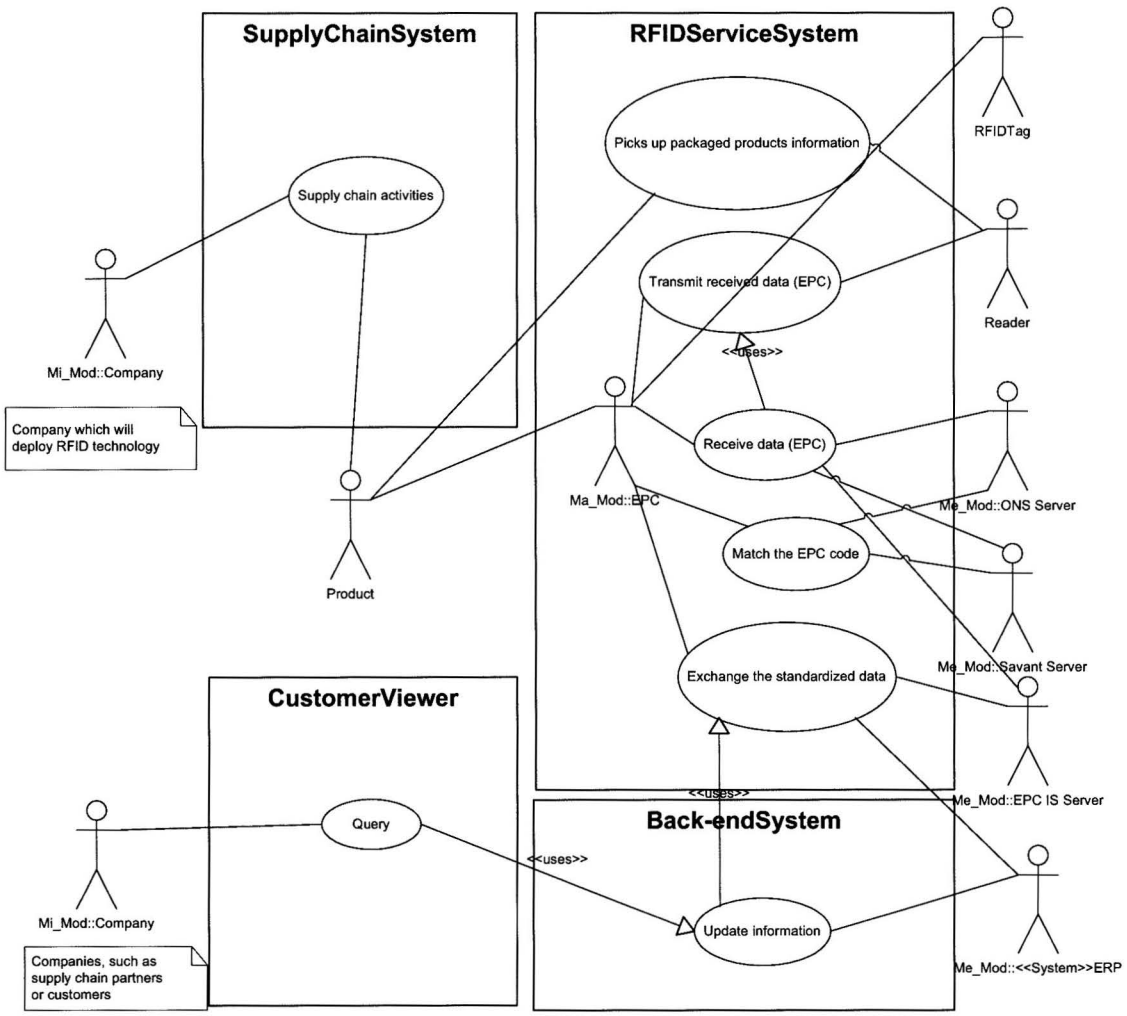

Figure 23 – Sub-system grouping Model (Pico-level)

Figure 24 – Use case scenario of RFID service system

Use Case	**Picks up packaged products information**
Priority	1
Goal	For future usage, such as: Update information , Exchange the standardized data, etc.
Actors	RFID Reader
Pre-conditions	Products have been tagged.
Post-conditions	RFID reader received radio waves send by tags.

Quality requirements	Good tag readability, real-time, accuracy. stable, can be processed 7by24
Scenario	RFID Service System
Description	When products pass the reader, and the reader receive the radio wave send by tag. The data captured by reader will be send to RFID middleware.

Table 10 – Use Case: Pick up information of packaged products

Use Case	**Transmits received data (EPC)**
Priority	1
Goal	For future usage, such as: Update information , Exchange the standardized data, etc.
Actors	RFID Reader, ONS server and Savant server
Pre-conditions	The reader receives the radio wave from tag.
Post-conditions	After the reader receive the EPC from tag, and send it to ONS server and Savant server.
Quality requirements	Accuracy, Stable, can be processed 7by24
Scenario	RFID Service System
Description	After RFID middleware receive the EPC data from readers, it intelligently filters and route it to the appropriate destinations. For example: filtering out duplicate reads and content-based routing

Table 11 – Use Case: Transmits/receive EPC numbers

Use Case	**Exchange the standardized data**
Priority	1
Goal	The data from RFID systems can be used by back-end systems, such as ERP and CRM, in order to improve the performance and efficiency of both technologies.
Actors	EPC IS server, back-end server
Pre-conditions	The data received by EPC IS server
Post-conditions	The EPC exchange to standardized code which can be received by back-end systems, such as ERP and CRM, etc.
Quality requirements	Stable, accuracy, real-time, can be processed 7by24
Scenario	RFID Service System
Description	RFID middleware should provide the messaging, routing, and connectivity features to integrate RFID data into existing SCM, ERP, WMS, or CRM systems.

Table 12 – Use Case: Exchange the standardized data

2. Micro Level

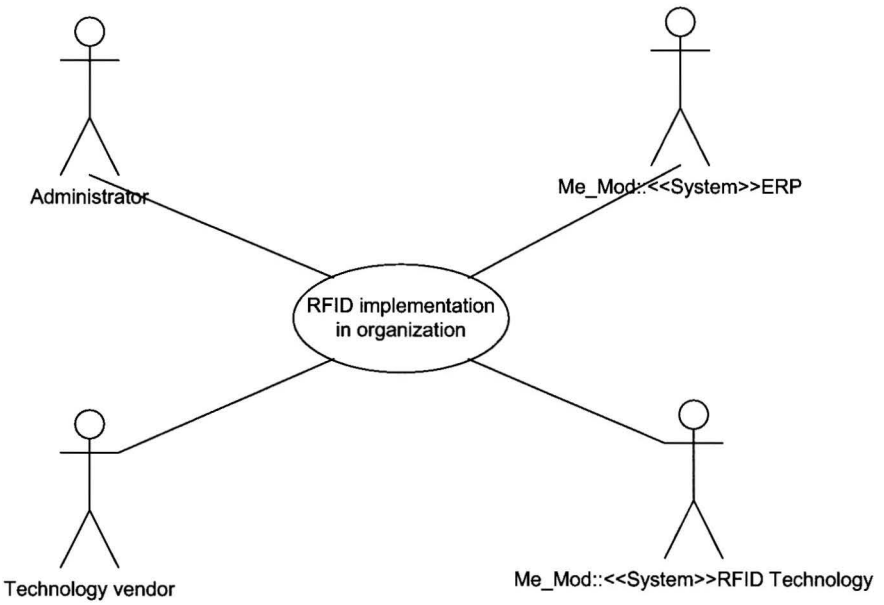

Figure 25 – Context Statement of Micro Level Project

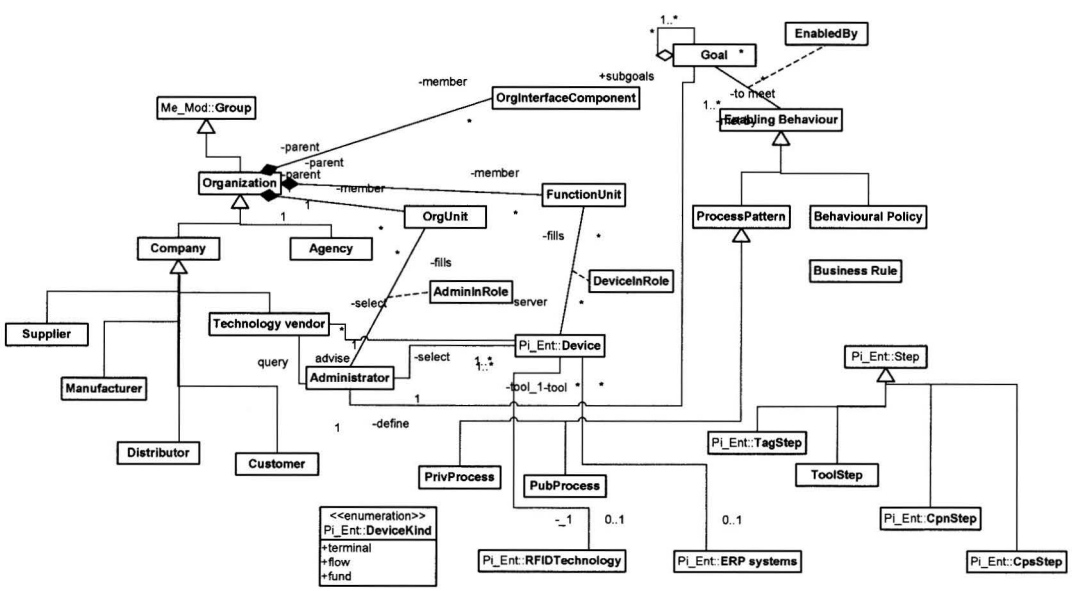

Figure 26 – Resource model in Micro Level

Entity	Description
Organization	The organization is a social arrangement which pursues collective goals, which controls its own performance, and which has a boundary separating it from its environment.
Company	The company is a form of business organization.
Agency	A business or service authorized to act for others.
Technology vendor	Software vendor, hardware vendor and consultancy.
Administrator	One who administers, especially business or public affairs; an executive.
OrgUnit	An Org Unit is a department, office, division, school, institute, or other unit responsible for some part of the organization's activities.
FunctionUnit	An entity of hardware, software, or both, capable of accomplishing a specified purpose.
EnablingBehaviour	An Enabling Behaviour is what is required to happen for one or more goals to be achieved.
Enabled by	Enabled by is a relationship concept that categorizes an association in a model between a goal and an Enabling Behaviour in which the goal is enabled by the associated behavior.
ProcessPattern	Process Pattern is model of how processes (e.g. business processes) in a given domain should be run.
BehaviouralPolicy	A behaviour that is necessary to enable the achievement of at least one goal, for whatever reason, including modeling purpose, be represented as a set of steps with a defined start point and end points.
Goal	A Goal is the purpose that a community has in executing a Business process.

Table 13 – Entity Description

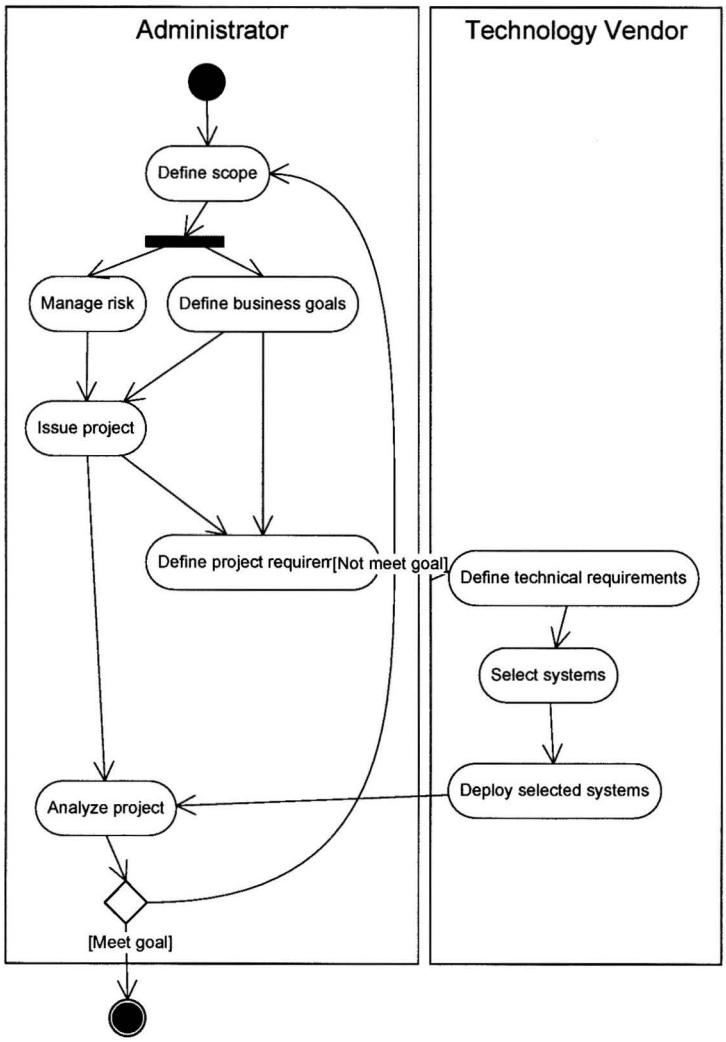

Figure 27 – Process of RFID Technology Deployment in Company

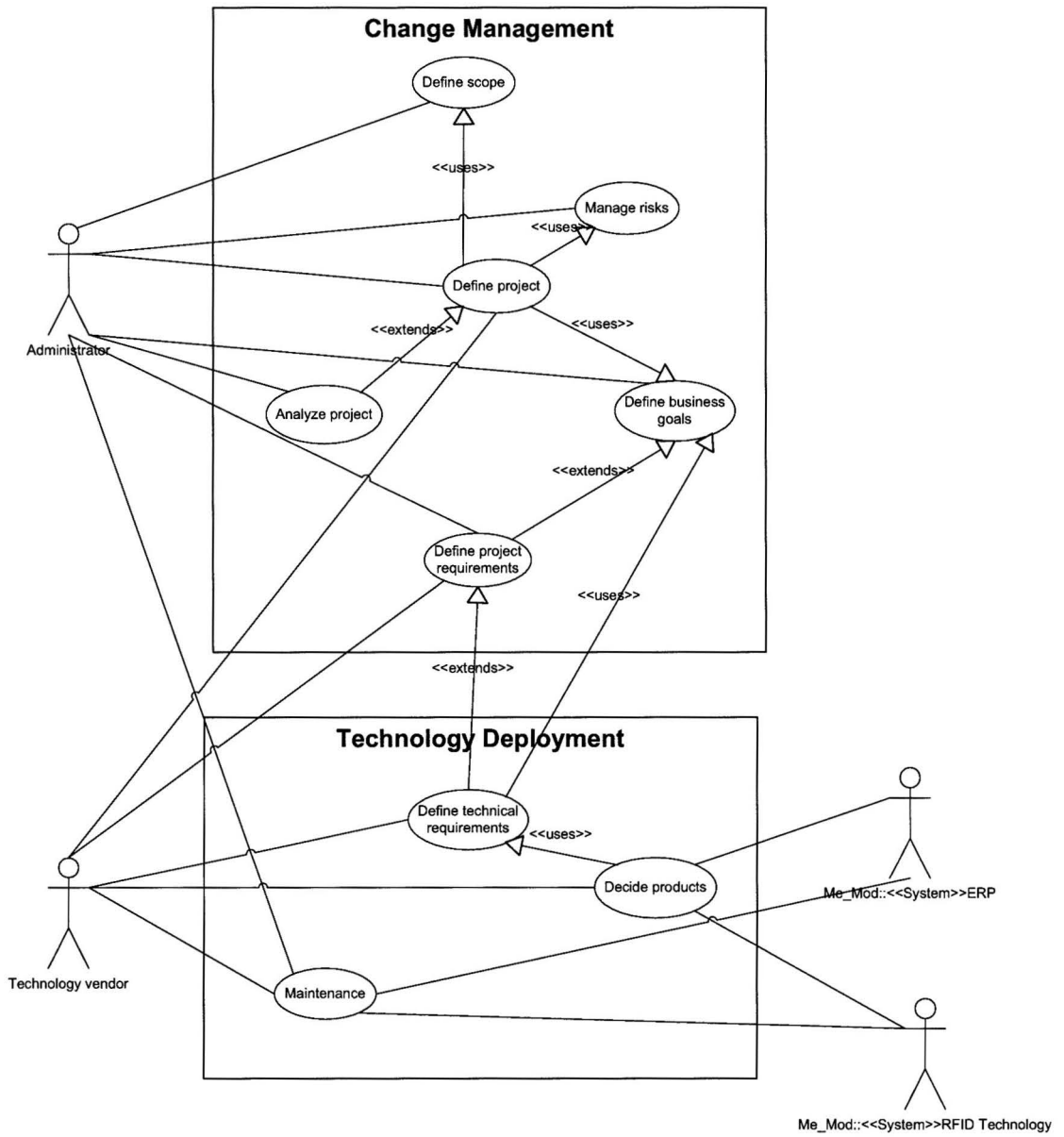

Figure 28 – Sub-system Grouping Model (Micro-level)

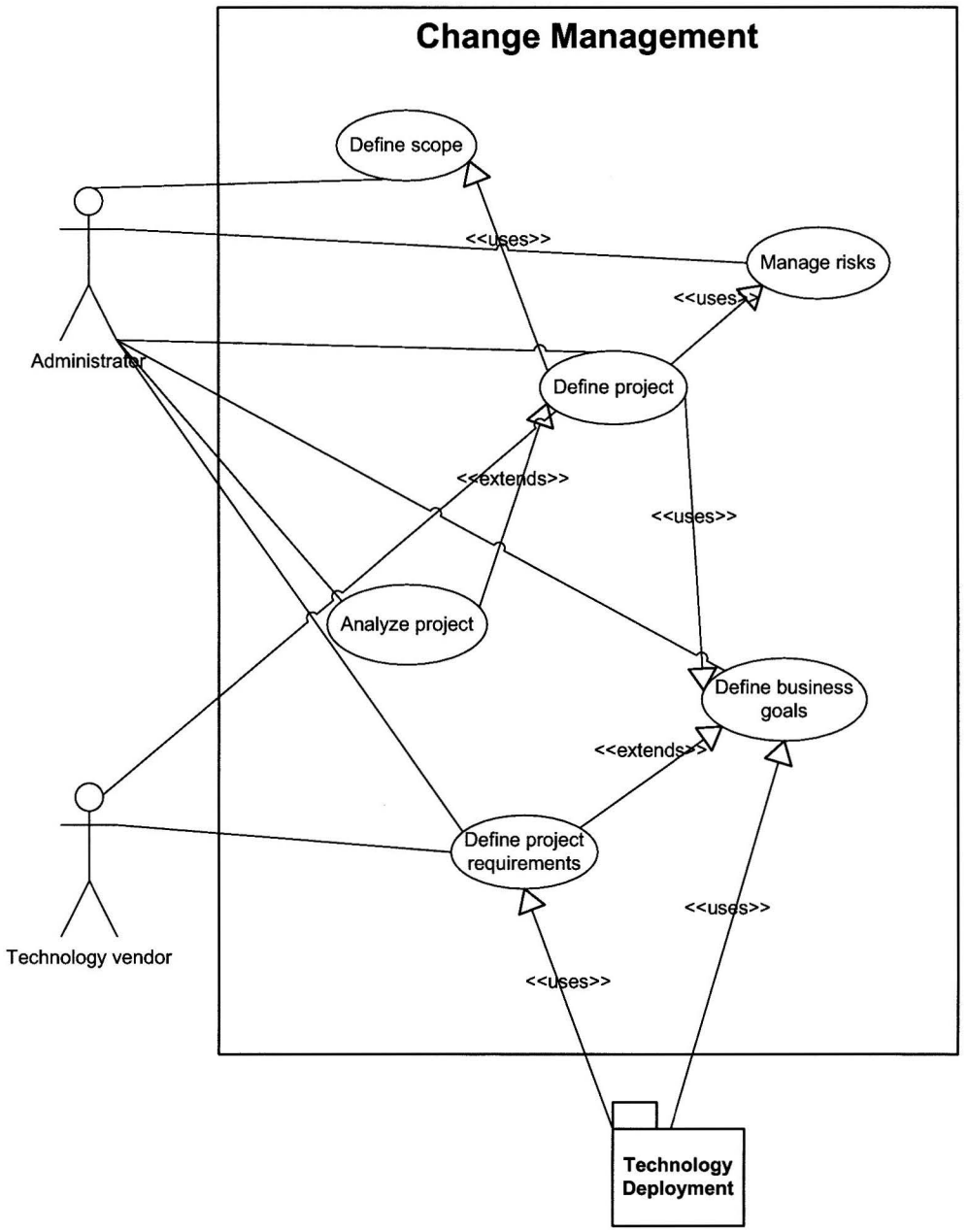

Figure 29 – Use Case Scenario of Change Management (Micro-level)

Use Case	**Define scope** (Micro Level/Company Level)
Priority	1
Goal	Problems identification
Actors	Administrator
Pre-conditions	Problems existed in supply chain (Micro Level/Company level)
Post-conditions	Find out the project to solve such problems
Scenario	Change Management
Description	Determine and give a clear introduction of what kind of problems the

	company faced, and where these problems located.

Table 14 – Use Case: Define scope (Micro Level/Company Level)

Use Case	**Define project**
Priority	1
Goal	Determine what kind of project the company will implement, such as RFID project.
Actors	Administrator, technology vendor
Pre-conditions	No specific project has been determined.
Post-conditions	The company decide to implement RFID project.
Scenario	Change Management
Description	In Company Level, the defining a project's give a common understanding for all project stakeholders. "Why", "Who" and "How" are the basic points.

Table 15 – Use Case: Define project

Use Case	**Manage risks**
Priority	1
Goal	Try to reduce or prevent risk-related cost.
Actors	Administrators
Pre-conditions	No risk management activities
Post-conditions	Find out the problems and challenging in RFID project
Scenario	Change Management
Description	Risk management can increase the chances of success and minimize the effect of loss that cannot prevent in company's RFID project. Risks in company's RFID project concludes: technology cost, security and privacy, and technology incompatible (RFID systems and ERP systems), etc.

Table 16 – Use Case: Manage risks

Use Case	**Analyze project**
Priority	1
Goal	Monitor the project implementing processes.
Actors	Administrator, technology vendor
Pre-conditions	Find out a suitable scorecard
Post-conditions	Analyze company's RFID project by using scorecard
Scenario	Change Management
Description	In Micro Level/Company Level, the company can choose Balanced Scorecard to analyze the RFID project. There are four perspectives in Balanced Scorecard: Financial perspective, Customer perspective, Internal Process perspective, and Learning & Growth perspective. The

	company can use the Balanced Scorecard before and after the RFID project, to see if the business process and performance has been improved because of the project.

Table 17 – Use Case: Analyze project

Use Case	Define business goals
Priority	1
Goal	Determine what kind of benefits and advantages the company can gain from the project implementation.
Actors	Administrator
Pre-conditions	
Post-conditions	Foundation of setting project requirement
Scenario	Change Management
Description	The obvious business goals of company's RFID project is reduce cost, improving supply chain visibility, and enabling real-time data collection.

Table 18 – Use Case: Define business goals

Use Case	Define project requirements
Priority	2
Goal	Specify the capabilities, features and attributes of the project.
Actors	Administrator
Pre-conditions	Clear business goals
Post-conditions	Clear description of project.
Scenario	Change Management
Description	The project requirements determine which elements will be included and excluded from the project. The project requirement would contain the following elements: the company's expectations, setting the stage for project planning, and establishing consensus among project participants.

Table 19 – Use Case: Define project requirements

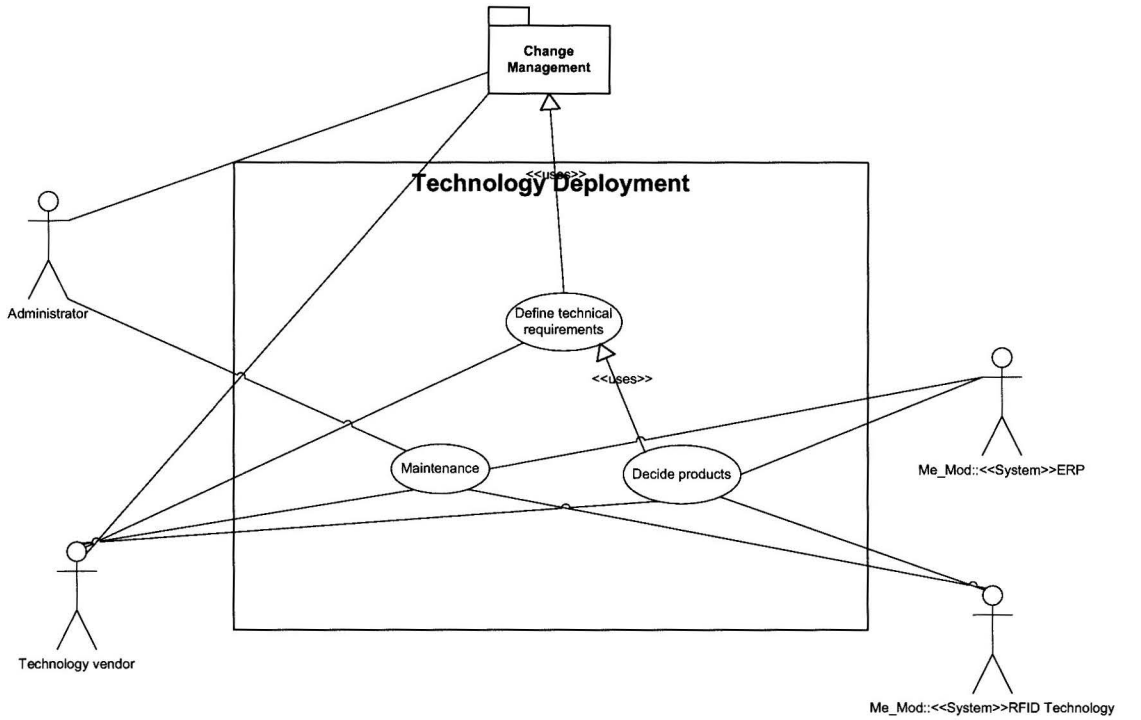

Figure 30 – Use Case Scenario of Technology Development

Use Case	Define technical requirements
Priority	2
Goal	Give a guideline to company of what kind of technology products to choose
Actors	Technology vendor
Pre-conditions	The company prepares to buy RFID and ERP products.
Post-conditions	The company has guideline from technology vendors
Scenario	Technology Deployment
Description	The technical requirements of company's RFID project include: low technology cost (RFID systems and ERP systems), high security and privacy level, systems (RFID systems and ERP systems) stability, systems (RFID systems and ERP systems) compatibility, etc.

Table 20 – Use Case: Define technical requirements

Use Case	Maintenance
Priority	2
Goal	Keep the systems running well.
Actors	Technology vendor
Pre-conditions	Systems in good/bad condition.
Post-conditions	Systems in good/acceptable condition
Scenario	Technology Deployment

Description	The technology vendors have responsibilities to keep the systems (RFID systems and ERP systems) in a good condition, in order to keep the smooth business process.

Table 21 – Use Case: Maintenance

3. Meso Level

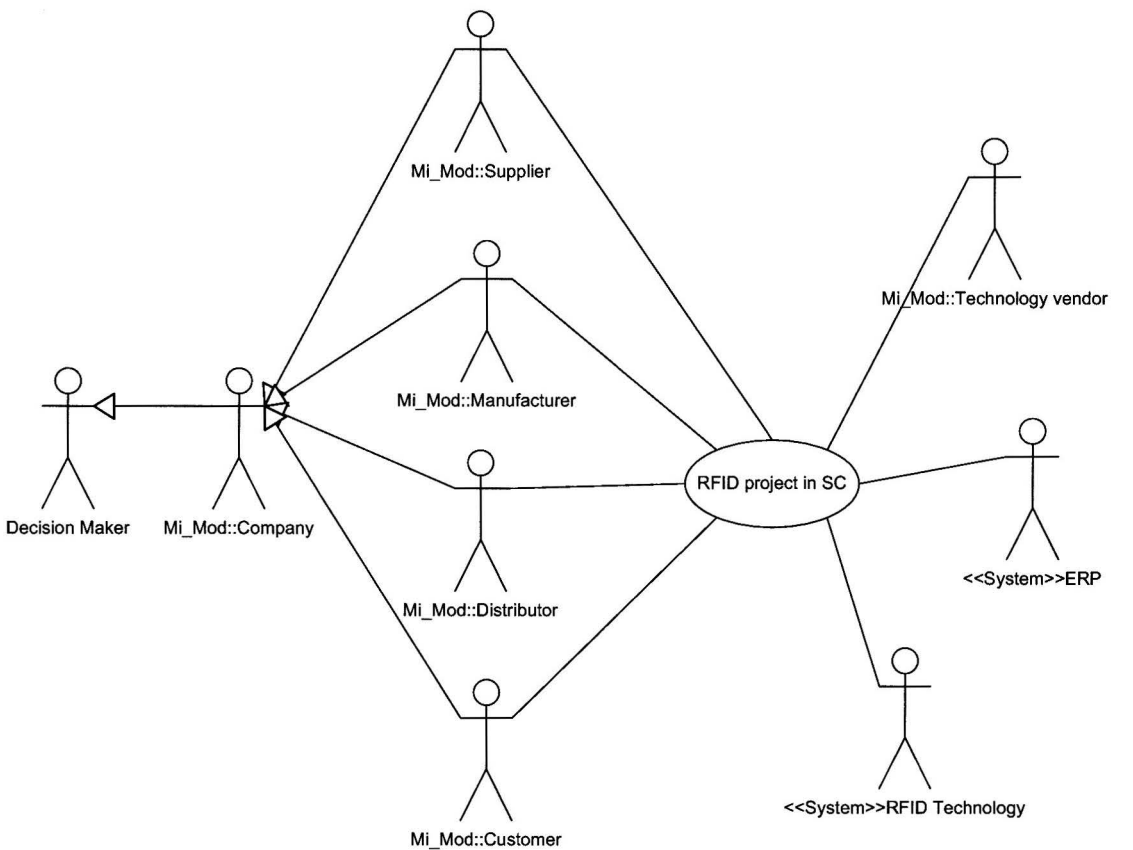

Figure 31 – Context Model-Actors Overview

Actor	Description
Decision Maker	Individual people or company, who can make the final decision.

Table 22 – Use Case Description of Meso-Level

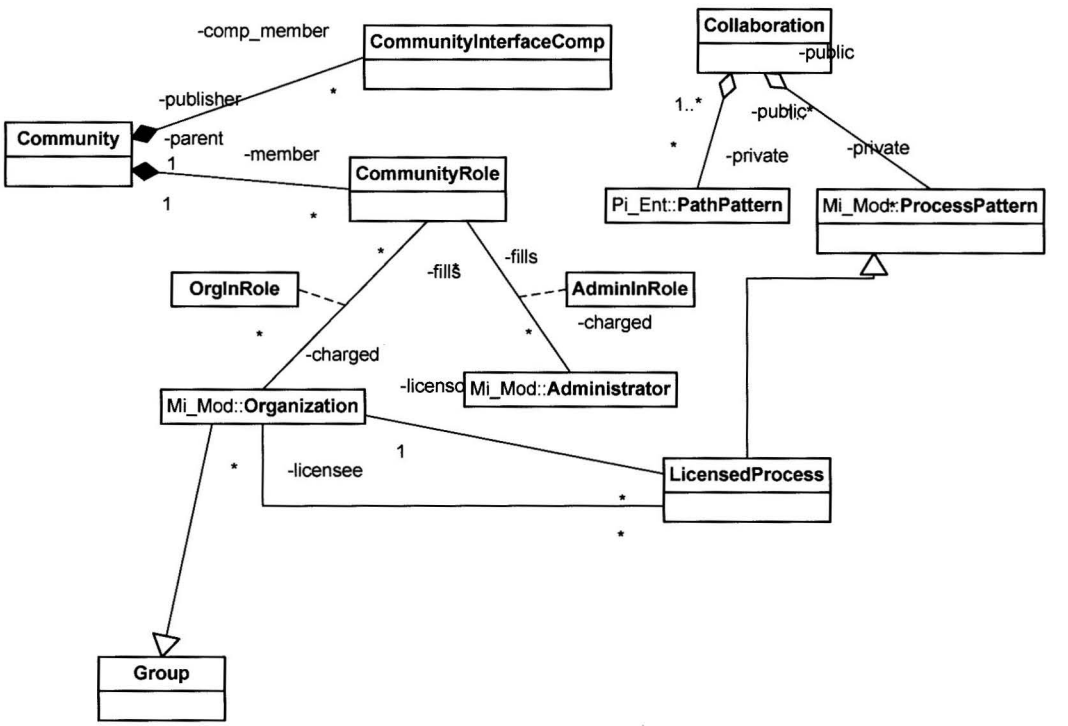

Figure 32 – Resource Model of Meso Level

Entity	Description
Community	A community is a collection of resources working together, in one or more processes, to achieve one or more goals.
CommunityRole	A Community Role is the behaviour of a community when performing one or more activities (business activities, project).
Collaboration	Collaboration is a recursive process where people or organizations work together toward an intersection of common goals.
PathPattern	Path Pattern is model of how path (e.g. tag path) in a given domain should be run.
LicensedProcess	Standard project process.

Table 23 – Entity Description

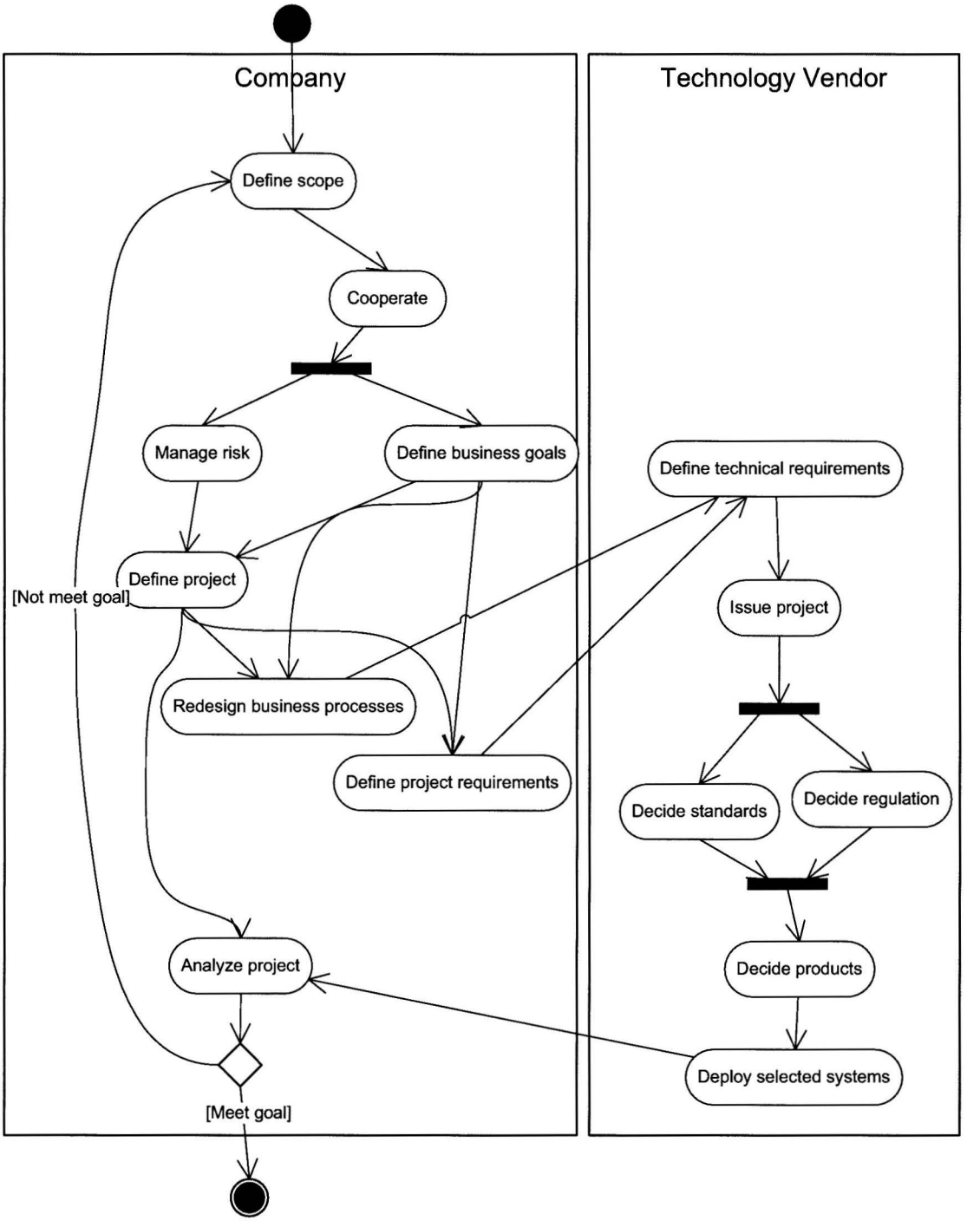

Figure 33 – Process of RFID Project Implementation in Supply Chain System

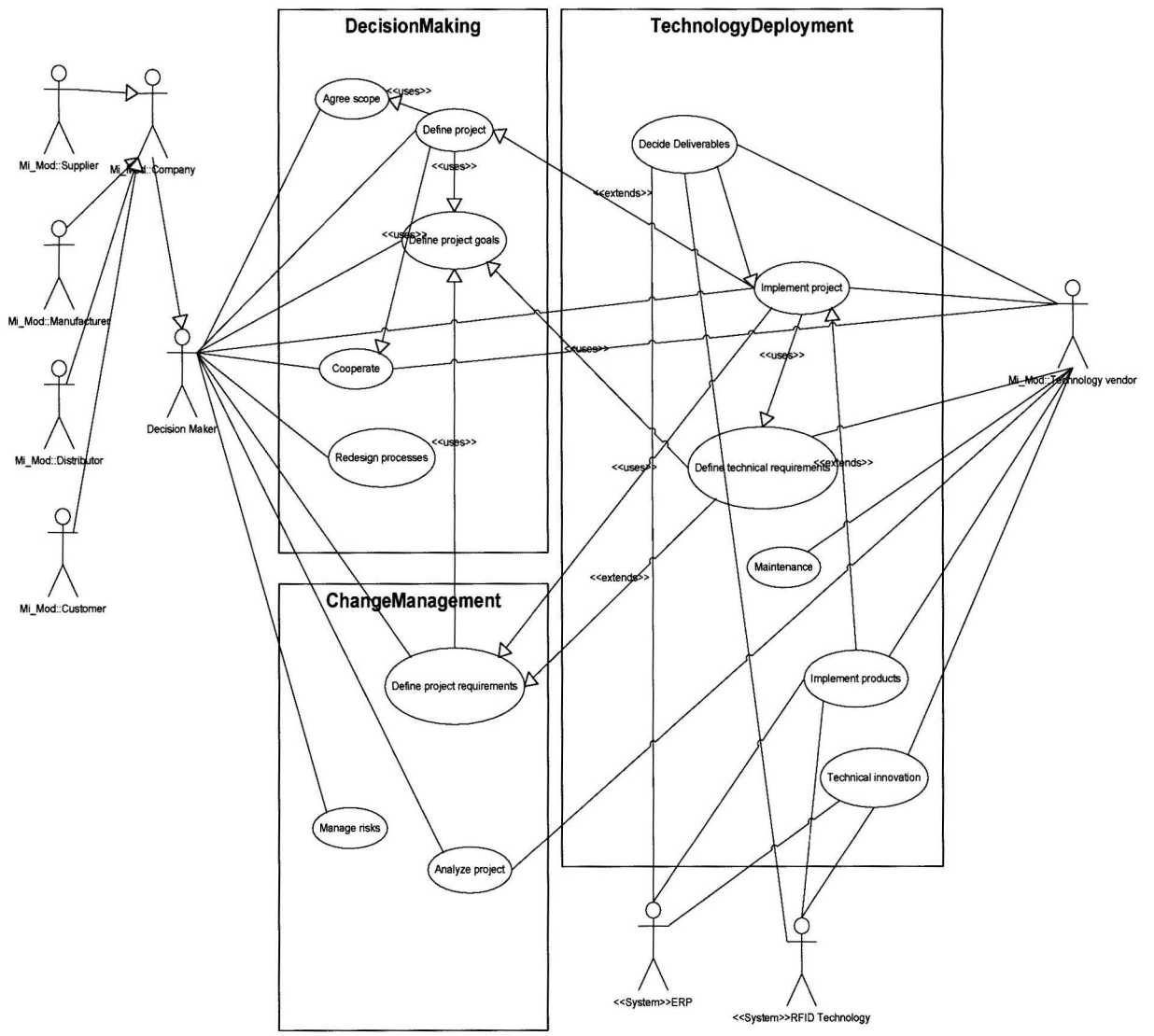

Figure 34 – Sub- system Grouping Model (Meso-level)

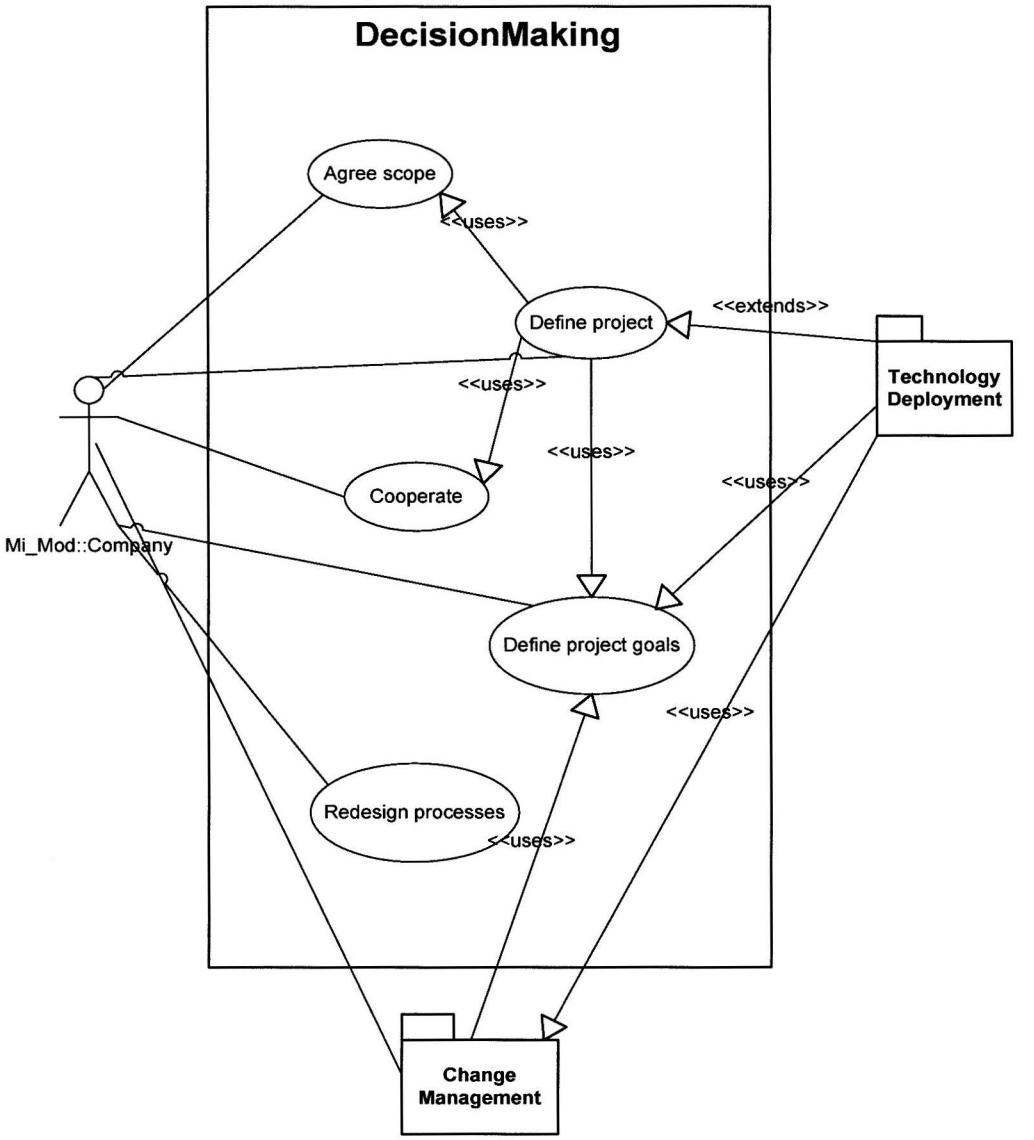

Figure 35 – Use Case Scenario of Decision Making

Use Case	**Agree Scope** (Meso Level/Supply Chain Level)
Priority	1
Goal	Problem identification
Actors	Companies in supply chain system.
Pre-conditions	Problems existed in supply chain (Meso Level/Supply Chain Level)
Post-conditions	Find out the project to solve the existing problems
Scenario	Decision Making
Description	Determine and give clear introductions to companies in whole supply chain systems, what kind of common problems they face, and who will participate in the project.

Table 24 – Use Case: Define Scope (Meso Level/Supply Chain Level)

Use Case	Define project
Priority	1
Goal	Determine what kind of project will be implemented in the supply chain systems.
Actors	Companies in supply chain system.
Pre-conditions	No specific project is determined.
Post-conditions	The companies in supply chain decide to implement RFID project.
Scenario	Decision Making
Description	In Supply Chain Level, the defining a project's give a common understanding for all project stakeholders (supply chain partners and technology vendor). "Why", "Who" and "How" are the basic points.

Table 25 – Use Case: Define project

Use Case	Cooperate
Priority	1
Goal	Get unanimous agreement between supply chain partners
Actors	Companies in supply chain system.
Pre-conditions	Supply chain partners have their own thought.
Post-conditions	Consensus established
Scenario	Decision Making
Description	The supply chain partners establish consensus on RFID project implementation, such as: decide standard, participants, and RFID/ERP products

Table 26 – Use Case: Cooperate

Use Case	Define business goals
Priority	1
Goal	Determine what kind of benefits and advantages the companies can gain from the project implementation.
Actors	Companies in supply chain system.
Pre-conditions	
Post-conditions	Foundation of setting project requirement
Scenario	Decision Making
Description	In Supply Chain Level, the common business goal is to improve the supply chain performance and efficiency, and reduce the operational cost.

Table 27 – Use Case: Define business goals

Use Case	Redesign business process
Priority	1
Goal	Improve the efficiency and effectiveness of the business processes that

	exist within and across supply chain partners.
Actors	Companies in supply chain system.
Pre-conditions	Companies have their owe business processes
Post-conditions	RFID reader received radio waves send by tags.
Scenario	Decision Making
Description	In this stage, the companies coordinate smoothly their supply chain activities and other business activities. According to Guha et al (1993), there are six stages in redesign business process: envision new processes, initiating change, process diagnosis, process redesign, reconstruction, and process monitoring.

Table 28 – Use Case: Redesign business process

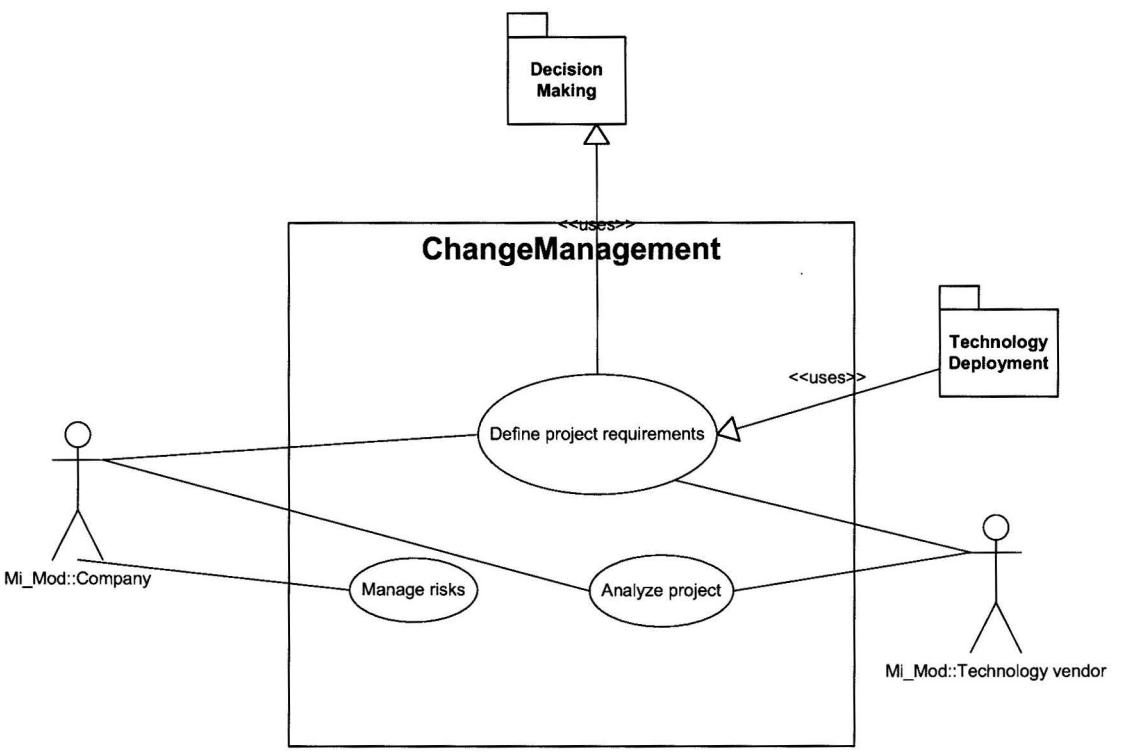

Figure 36 – Use Case Scenario of Change Management

Use Case	**Define project requirements**
Priority	1
Goal	Specify the capabilities, features and attributes of the project (Meso Level/Supply Chain Level).
Actors	Companies in supply chain system, technology vendor
Pre-conditions	Clear business goals
Post-conditions	Clear description of project.
Scenario	Change Management
Description	The project requirements determine which elements will be included

	and excluded from the project. In Supply Chain Level, the project requirement would contain the following elements: the supply chain partners' expectations, setting the stage for project planning, and establishing consensus among project participants, etc.

Table 29 – Use Case: Define project requirements

Use Case	Manage risks
Priority	1
Goal	Try to reduce or prevent risk-related cost.
Actors	Companies in supply chain system.
Pre-conditions	Potential problems exist.
Post-conditions	Find out potential problems and challenges
Scenario	Change Management
Description	In Supply Chain Level, the problems and challenges faced by supply chain partners would include: data sharing between supply chain partners, unifying standards, security and privacy, etc.

Table 30 – Use Case: Manage risks

Use Case	Analyze project
Priority	1
Goal	Monitor the project implementing processes.
Actors	Companies in supply chain system, technology vendor
Pre-conditions	Find out a suitable scorecard
Post-conditions	Analyze RFID project by using scorecard
Scenario	Change Management
Description	In Meso Level/Supply Chain Level, the supply chain partners use Project Performance Scorecard to analyze the RFID project. Six perspectives can be used to analyze the project implementation: Project Process perspective, Stakeholder perspective, Benefit perspective, learning & Innovation perspective, Quality perspective, and Use perspective.

Table 31 – Use Case: Analyze project

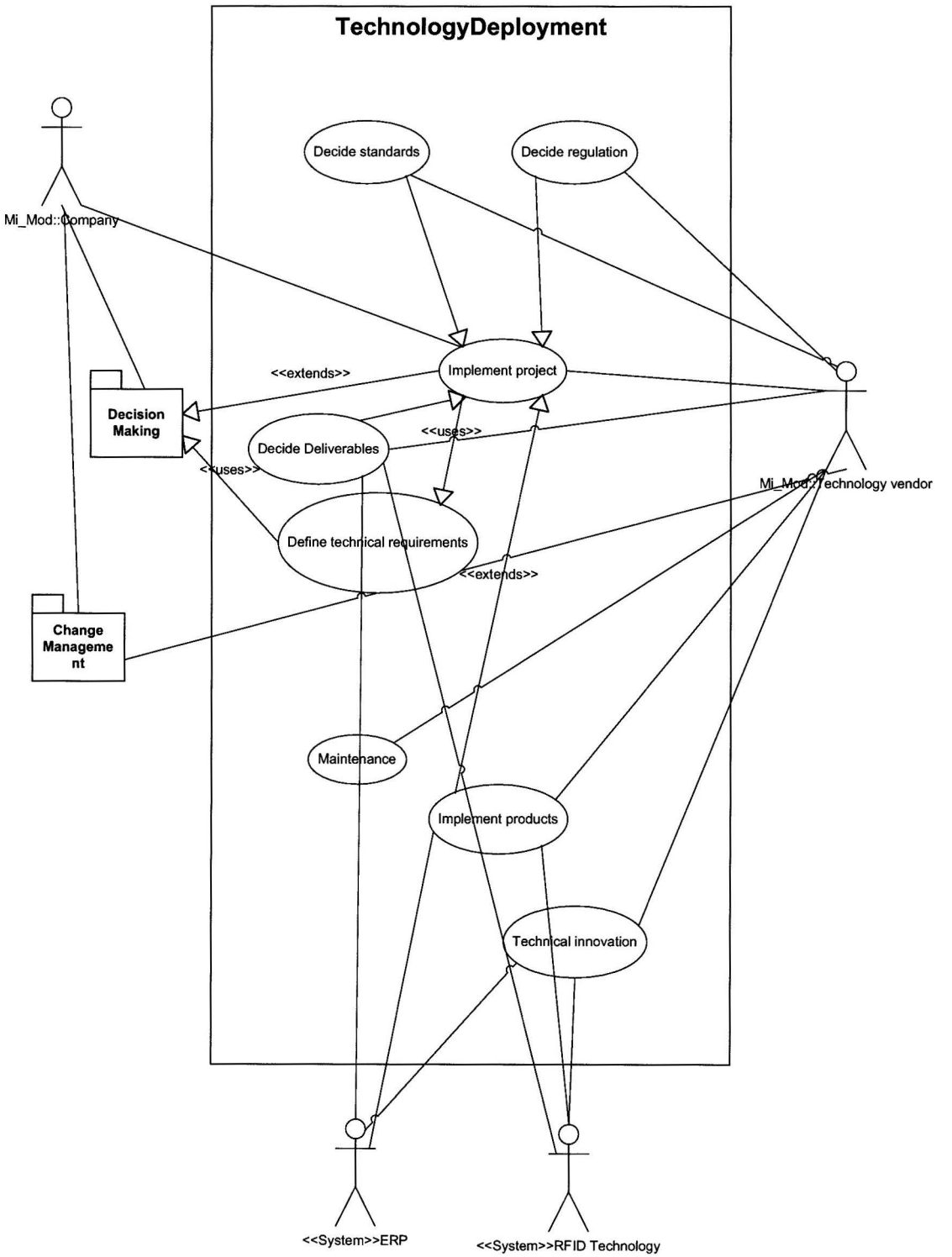

Figure 37 – Use Case Scenario of Technology Deployment

Use Case	Implement project
Priority	1
Goal	Launch project
Actors	Technology vendor, companies in supply chain system
Pre-conditions	Pre-analyze of project.
Post-conditions	Implement project
Scenario	Technology Deployment
Description	After pre-analysis of project, the supply chain partners decide to implement RFID project.

Table 32 – Use Case: Issue project

Use Case	Decide standards
Priority	1
Goal	Enable interoperability.
Actors	Technology vendor
Pre-conditions	No specific standard used in industry.
Post-conditions	Technical standards decided.
Scenario	Technology Deployment
Description	EPCglobal and ISO are two main institutions. For example, Wal-Mart and METRO Group have adopted EPCglobal Gen2 standard.

Table 33 – Use Case Decide standards

Use Case	Decide regulation
Priority	1
Goal	Enable interoperability.
Actors	Technology vendor
Pre-conditions	Different regulations exist.
Post-conditions	Choose appropriate one.
Scenario	Technology Deployment
Description	The parameters of RFID regulation include: frequency, bandwidth, maximum power, channels, duty cycle, and range, etc.

Table 34 – Use Case: Decide regulations

Use Case	Decide products
Priority	2
Goal	Decide the appropriate RFID systems and ERP systems to use.
Actors	Technology vendor, RFID systems, ERP systems
Pre-conditions	No specific products.
Post-conditions	Find out specific products which are suitable for project.
Scenario	Technology Deployment
Description	Technology vendors help companies to find out suitable technology

	products to deploy, such as products with lower price, high security and privacy level, and stable, etc.

Table 35 – Use Case: Decide products

Use Case	Define technical requirements
Priority	1
Goal	Give a guideline to companies of what kind of technology products to choose
Actors	Technology vendor
Pre-conditions	The companies in supply chain system plan to buy RFID and ERP products.
Post-conditions	The company has guideline from technology vendors
Scenario	Technology Deployment
Description	The technical requirements of company's RFID project include: low technology cost (RFID systems and ERP systems), high security and privacy level, systems (RFID systems and ERP systems) stability, systems (RFID systems and ERP systems) compatibility, etc.

Table 36 – Use Case: Define technical requirements

Use Case	Maintenance
Priority	2
Goal	Keep the systems running well.
Actors	Technology vendor, companies in supply chain system
Pre-conditions	Project in good/bad condition.
Post-conditions	Project in good/acceptable condition
Scenario	Technology Deployment
Description	In Meso Level/Supply Chain Level, the "Maintenance" contains two parts: the technology vendors keep the systems (RFID systems and ERP systems) in a good condition; the companies have to keep coordinating with each other and giving project-related training to their employees.

Table 37 – Use Case: Maintenance

Use Case	Technical innovation
Priority	1
Goal	Maintain sustainable development
Actors	Technology vendor
Pre-conditions	Old technology with lower efficiency and high cost.
Post-conditions	Updated technology
Scenario	Technology Deployment
Description	Technology innovation is one of the key issues of industry

	development. In supply chain system, technical innovation of RFID systems and ERP systems helps stakeholders reduce technology deployment cost and optimize their business process.

Table 38 – Use Case: Technical innovation

4. Macro Level

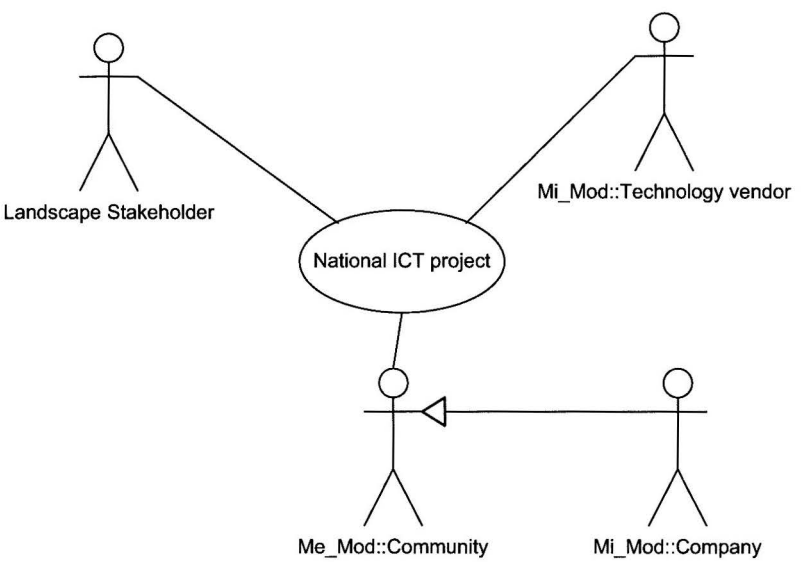

Figure 38 – Context Model-Actors Overview (Macro-level)

Actor	Description
Landscape Stakeholder	The stakeholder who plans and issues the project in national level, such as national government.

Table 39 – Actor description of Macro Level

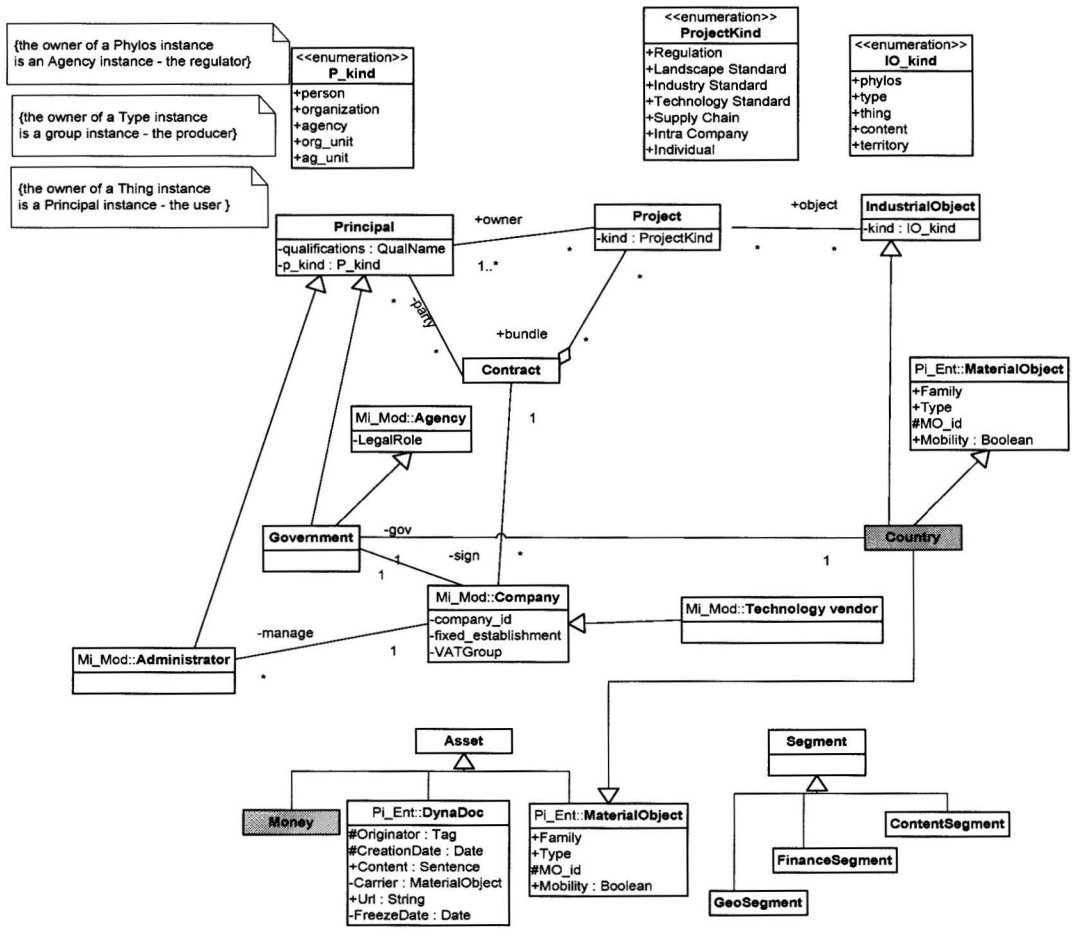

Figure 39 – Resource Model in Macro Level

Entity	Description
Principal	A main participant in a situation
Government	A group of people who have the power to make and enforce laws for a country or area.
Contract	A contract is an exchange of promises between two or more parties to do or refrain from doing an act which is enforceable in a court of law.
Project	A project is a collaborative enterprise, frequently involving research or design, that is carefully planned to achieve a particular aim
Asset	In business and accounting, assets are everything owned by a person or company (all tangible and intangible property) that can be converted into cash. It can also be defined as a probable future economic benefit obtained or controlled by a person or company as a result of a past transaction or event.
Segment	Any of the parts into which something can be divided.

Table 40 – Entity Description

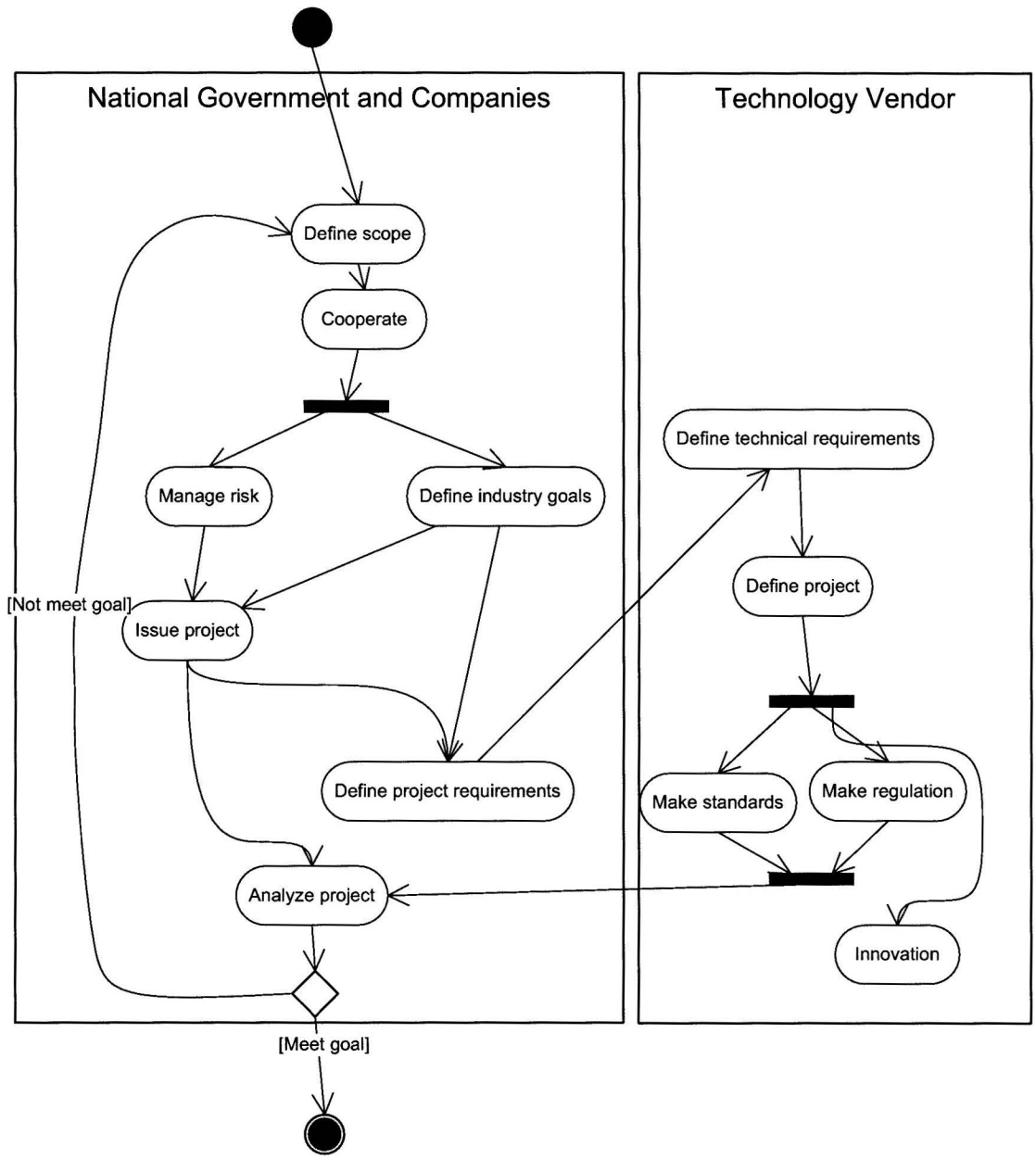

Figure 40 – ICT-reliant Project Process (Macro/National level)

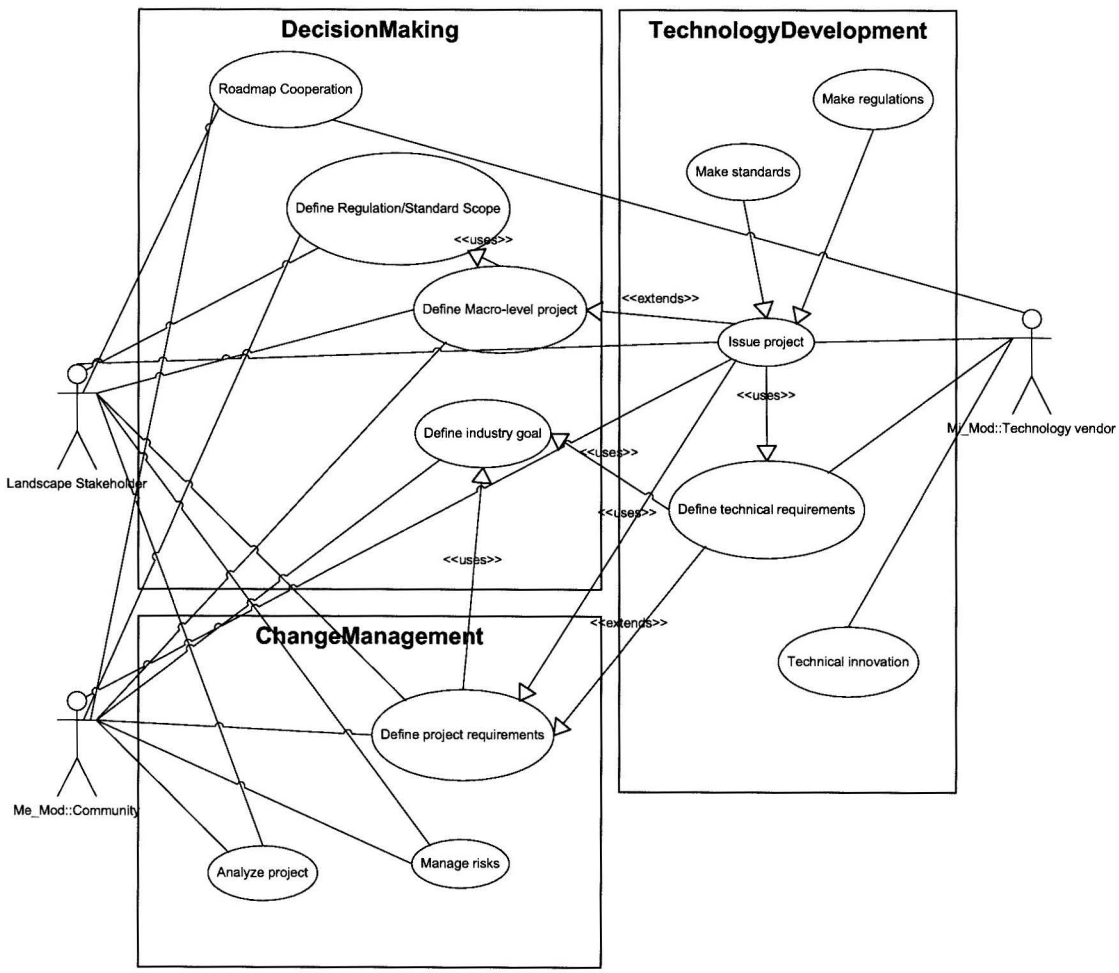

Figure 41 – Sub-system Grouping Model (Macro/National level)

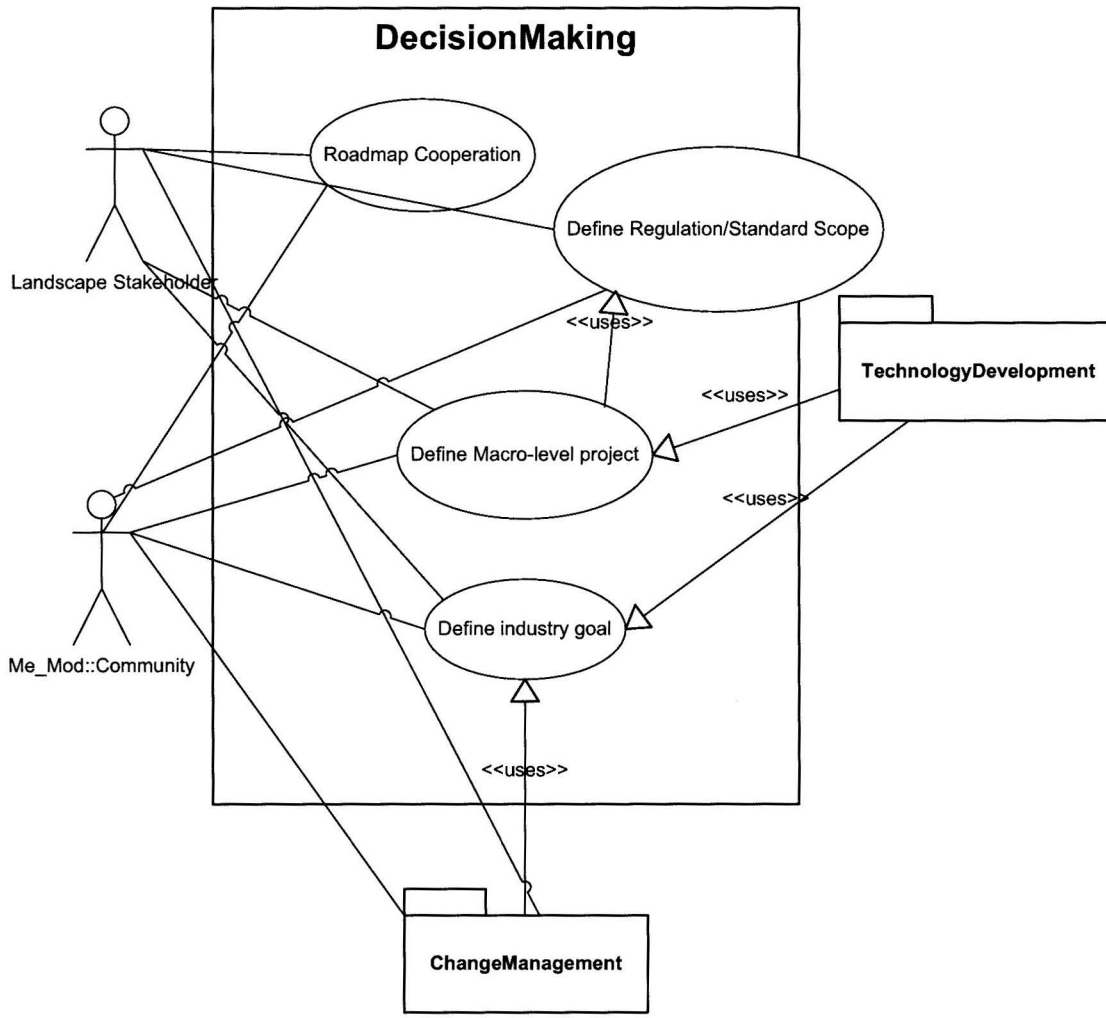

Figure 42 – Use Case Scenario of Decision Making

Use Case	**Define Regulation/Standard Scope** (Macro Level/National Level)
Priority	1
Goal	Problem identification
Actors	National government, companies in certain industry
Pre-conditions	Problems existed in supply chain industry (Macro Level/National Level)
Post-conditions	Find out the project to solve the existing problems
Scenario	Decision Making
Description	In national level, the national government, companies, and technology vendor get together to determine what kind of problems exist in industries, and which business domain need to be improved.

Table 41 – Use Case: Define scope

Use Case	Define Macro-level project
Priority	1
Goal	Determine what kind of project will be implemented in the supply chain systems, such as ICT-reliant project.
Actors	National government, companies in certain industry.
Pre-conditions	No specific project is determined.
Post-conditions	Decide to implement ICT-reliant project
Scenario	Decision Making
Description	In order to facilitate the economic development, the national government launches ICT-reliant projects in different industries.

Table 42 – Use Case: Define project

Use Case	Define industry goal
Priority	1
Goal	Determine the needs of specific industry.
Actors	National government, companies in certain industry
Pre-conditions	
Post-conditions	Foundation of setting project requirement.
Scenario	Decision Making
Description	Different industries have their own goals. For example, the supply chain industry needs to improve supply chain activities performance and efficiency, and reduce the operational cost.

Table 43 – Use Case: Define industry goal

Use Case	Roadmap Cooperate
Priority	1
Goal	Get unanimous agreement among national government and companies in different industries
Actors	National government, companies in certain industry
Pre-conditions	Different solutions exist
Post-conditions	Consensus of specific solution established
Scenario	Decision Making
Description	National government and companies in certain industry establish consensus on specific project implementation (ICT-reliant project), such as: decide standard, participants, and RFID/ERP products

Table 44 – Use Case: Cooperate

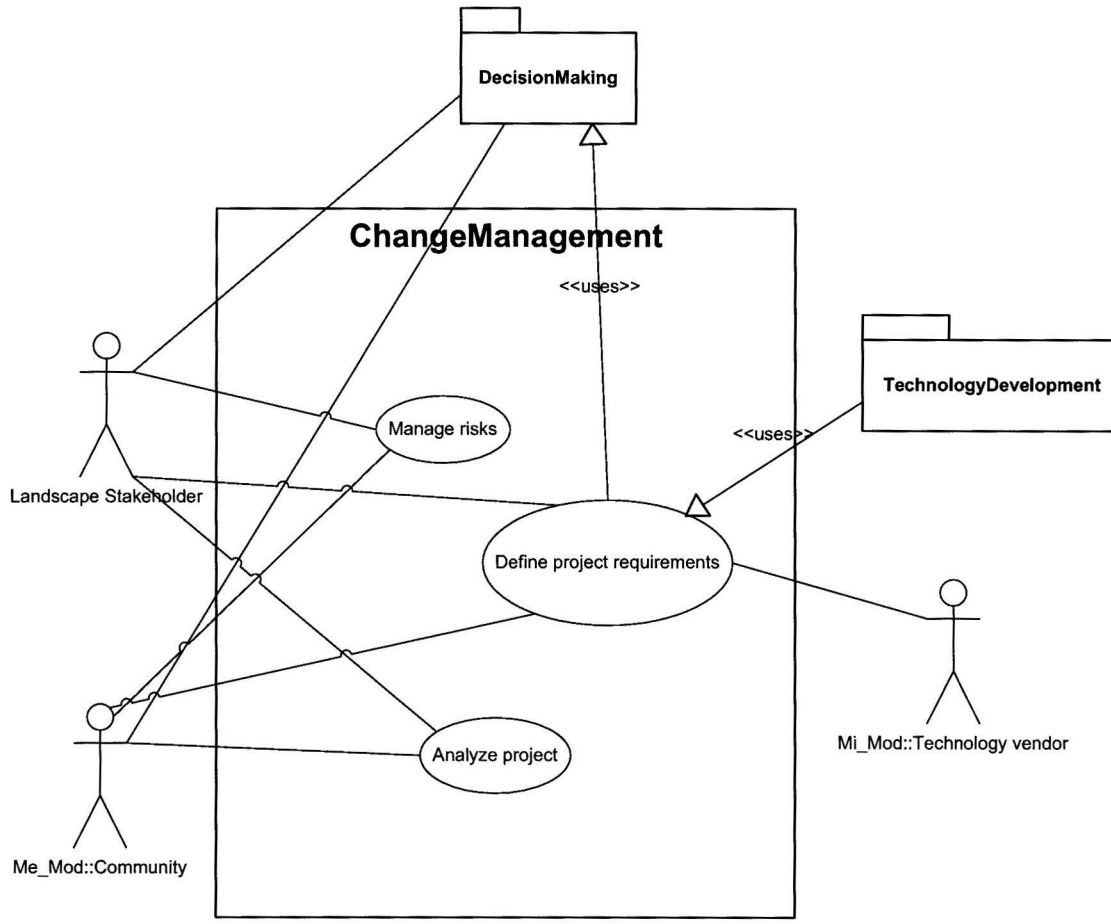

Figure 43 – Use Case Scenario of Change Management

Use Case	Manage risks
Priority	1
Goal	Reduce different risks of new project
Actors	National government, companies in certain industry
Pre-conditions	Potential problems exist
Post-conditions	Find out potential problems and challenges
Scenario	Change Management
Description	In national level, national government, companies in certain industry and technology vendors work together to manage uncertainties related to the project, such as environment, technology, humans, organization and politics.

Table 45 – Use Case: Manage risks

Use Case	Define project requirements
Priority	1
Goal	Specify the capabilities, features and attributes of the project (Macro level/National level)
Actors	National government, companies in certain industry
Pre-conditions	Clear business goals
Post-conditions	Clear description of project
Scenario	Change Management
Description	In national level, the critical project requirement is that national government, technology vendors, and potential project participants get together to find out the solution project which can fulfills the current needs of as many participants as possible.

Table 46 – Use Case: Define project requirements

Use Case	Analyze project
Priority	1
Goal	Monitor the project implementing processes
Actors	National government, companies in certain industry, technology vendor
Pre-conditions	Find out an appropriate scorecard
Post-conditions	Analyze project
Scenario	Change Management
Description	In National level, the Project Performance Scorecard is used to analyze the ICT-reliant project. Six perspectives included in PPS: Project Process perspective, Stakeholder perspective, Benefit perspective, Learning & Innovation perspective, Quality perspective, and Use perspective.

Table 47 – Use Case: Analyze project

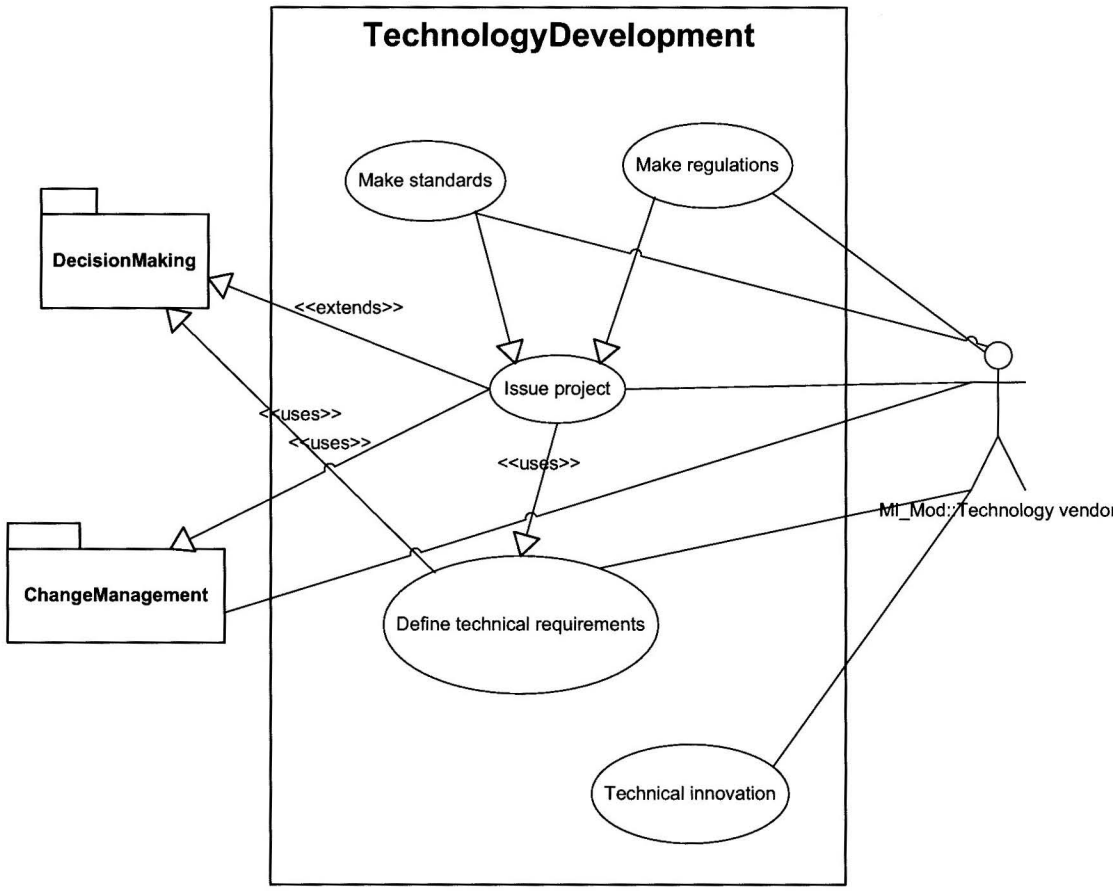

Figure 44 – Use Case Scenario of Technology Development

Use Case	Issue project
Priority	1
Goal	Plan to start project
Actors	Technology vendor, national government, companies in certain industry
Pre-conditions	Pre-analysis of project
Post-conditions	Implement project
Scenario	Technology Development
Description	After pre-analysis of project, participants decide to implement specific project

Table 48 – Use Case: Issue project

Use Case	Make standards
Priority	1
Goal	Promote interoperability
Actors	Technology vendor

Pre-conditions	
Post-conditions	Global standard EPC code
Scenario	Technology Development
Description	Make standard EPC code.

Table 49 – Use Case: Make standards

Use Case	**Make regulations**
Priority	1
Goal	Promote interoperability
Actors	Technology vendor
Pre-conditions	
Post-conditions	Different regulations for different regions
Scenario	Technology Development
Description	Different regions have different regulations. For example, different countries have different UHF frequencies: 865-868MHz in Europe, 902-928MHz in USA and Canada, and 918-926MHz in Australia, etc.

Table 50 – Use Case: Make regulation

Use Case	**Define technical requirements**
Priority	1
Goal	Give guideline of what kind of specific technology to use for project
Actors	Technology vendor
Pre-conditions	Plan to issue project
Post-conditions	Clear guideline
Scenario	Technology Development
Description	The technology vendors give a clear guideline of technology requirements, which can help government and companies choose appropriate technology for certain project.

Table 51 – Use Case: Define technical requirements

Use Case	**Technical innovation**
Priority	1
Goal	Help companies achieve their business goals
Actors	Technology vendor
Pre-conditions	Technology which meets the requirements of certain industry has been invented.
Post-conditions	Standards and regulations are made.
Scenario	Technology Development
Description	The technical innovation is one of the critical points of business

	success; the new and appropriate technology can help companies in certain industry improve performance and efficiency of business activities. In national level, Technology Innovation main focus on make standards and regulations for certain technology.

Table 52 – Use Case: Technical innovation