Issues and Formulas for Sustainable Profitability of an Embedded Software Business

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Abstract

To be making continuous stable profit is one of the most important activities for the enterprises as profit-making organizations. Moreover, the industry of which mainly perform development, without performing manufacturing nor selling products, especially the embedded software enterprises, must make the steady profit by each development to make the continuous stable profit and profit variation causes a threat to the stable business management. However, in the embedded software development business, which is in the midway stage of the development of industrialization, the profit variation is wide on some development items. The big issues in embedded software enterprises are how much can the width of the variations in profits distribution straiten and profit ratio increase.

In this study, the purpose is to show the formulas of producing stable profit and high profit ratio, by generating hypothesis and its verification to the variation factors of profit ratio. Further, we specified some models during the validity confirmation of hypothesis by verify various data of the past embedded software development.

Purpose of Study

In this study, the purpose is to show the formulas of producing stable profit and high profit ratio, by generating hypothesis and its verification to the variation factors of profit ratio. Further, we specified some models during the validity confirmation of hypothesis by verify various data of the past embedded software development.

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Situation analysis of embedded software business

The electronics device industry has grown much in response to market demand for product diversification, product cost reduction and rapid market cycle of new products. Against this backdrop, digitalization of electronic devices is accelerating rapidly, and capacity of embedded software is substantially increasing. Accordingly, the percentage of embedded software development cost is increasing at a staggering pace in electronic device development.

While the rapid expansion of embedded software is going on, the percentage of defective embedded software is rising among other causes of electronic device failures. The number of engineers with expertise on electricity and electronics, which are typically required for embedded software, is increasing ever, but it has failed to keep pace with expansion of the development. There still are far less engineers than required.

We are going to check these situations the above by looking actual data on following pages.

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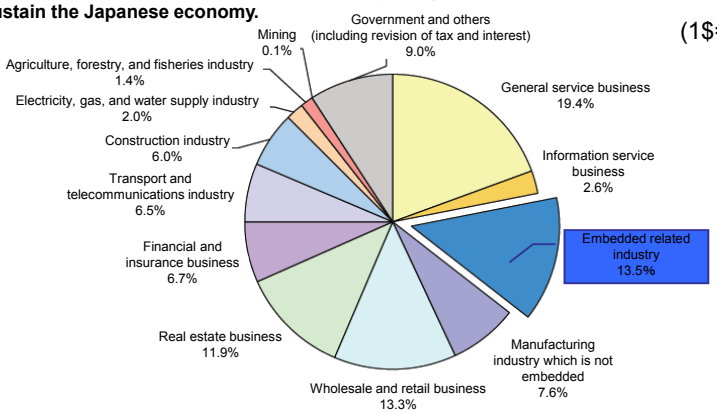
Current Situation of Embedded Software Industry

–Industry size of embedded-device-related manufacturing-

- **According to the Cabinet Office Statistics of 2007, the embedded-device-related industry generates \69.6 trillion ($682 billion) in scale, contributing to 13.5% of gross domestic product of Japan. Thus, the embedded software industry has grown to become one of the industries that sustain the Japanese economy.**

(1$=\102)



(Source: Cabinet Office 'Annual Report on National Accounts of 2007')

Fig.1: Embedded device related manufacturing industry in (nominal) GDP of 2007

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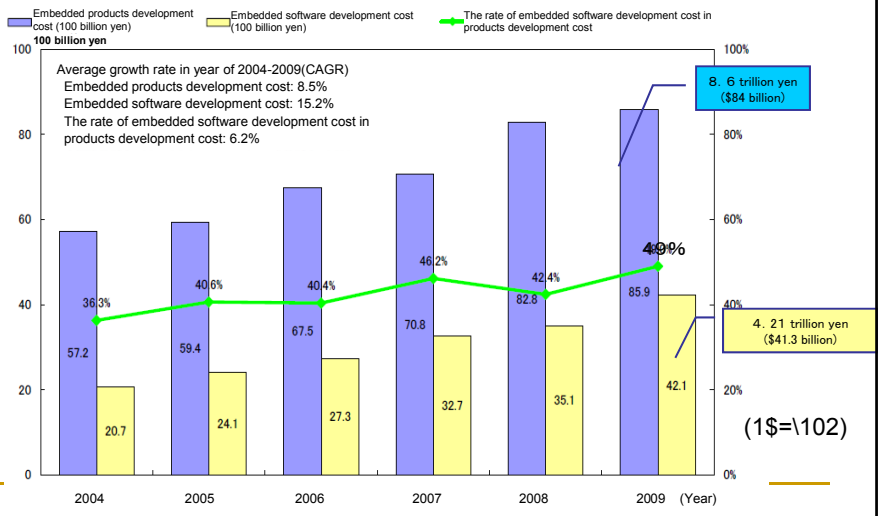
Situation analysis –Development cost for embedded software-

- Development cost for embedded-software-related products totals to ¥8.6 trillion($84 billion), of which 49.0% or ¥4.21 trillion ($41.3 billion) (year-to-year increase of 19.9%) is spent on embedded software development. Annual growth rate of embedded software development cost is on the rise at 15.2% over the five years.



(Source: METI of Japan, 'Embedded Software Industry Survey 2009')

Fig.2: Embedded product development cost and embedded software development cost

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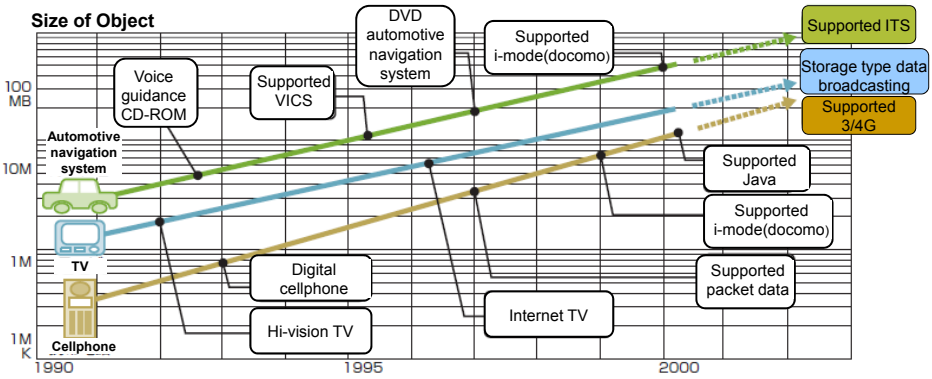
Situation analysis –Program capacity of embedded software-

The rapid digitalization and diversifying functions of these products have resulted in a dramatic increase of software in program capacity.



(Source: SEC Journal. 2009, Vol. 5, No. 5, p.275)

Fig.3: Size of Electronic information device software

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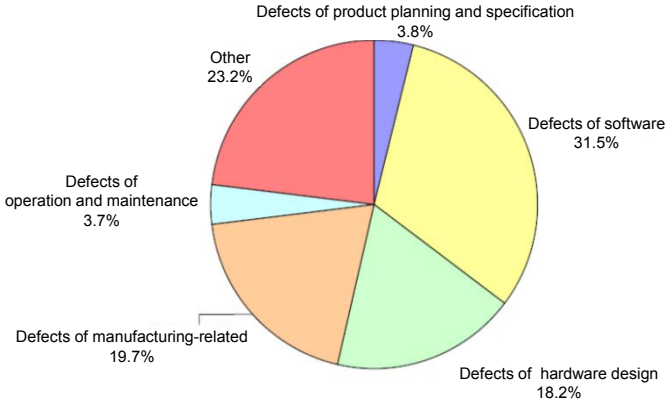
Situation analysis –Defects in embedded-software products-

- The biggest post-shipment quality issue with embedded software products is defective software devices.



(Source: METI of Japan, 'Embedded Software Industry Survey 2009')

Fig.4: Causes of post-shipment quality issues

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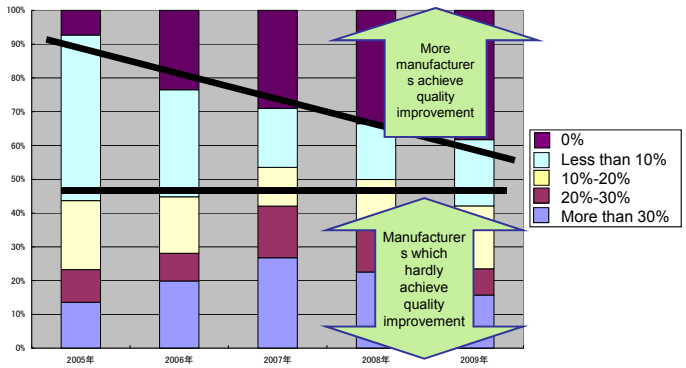
Situation analysis -Polarization of embedded software in quality-

- According to the ratio of post-shipment defects in embedded software devices, the percentage of companies which report of no defects with software steadily increases over the last five years from 7.3% to 38.2%. Contrary to the increase of zero defect companies, there is little change to the ratio of companies with more than 10% incidence rate of defects. As illustrated by the chart, the quality of the embedded software is polarized.



(Produced by the author based on the data of METI of Japan, 'Embedded Software Industry Survey 2007, 2008 and 2009')

Fig.5: Post-shipment incidence rate of defective quality in embedded software

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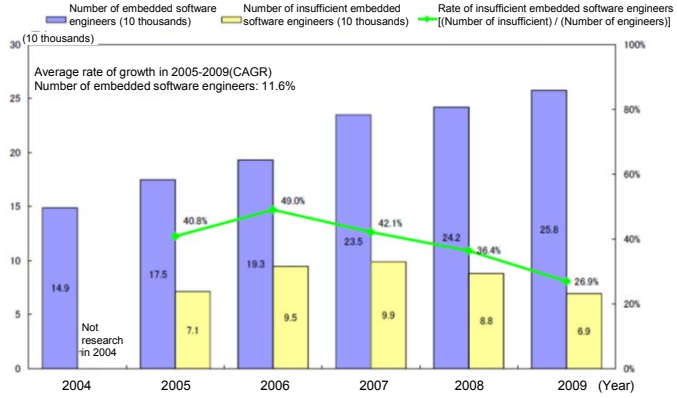
Situation analysis -Insufficient embedded software engineers-

- There are 258,000 embedded software engineers in Japan, which shows year-to-year increase of 6.4%. The number steadily increases every year. The scarcity of engineers is mitigated from 88,000 persons of 2008 to 69,000 persons. However, the industry is still grossly understaffed with skilled engineers.



(Source: METI of Japan, 'Embedded Software Industry Survey 2009')

Fig.6: Number of embedded software engineers (on FY2007 basis)

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Current situation surrounding embedded software business

- The embedded-device-related manufacturing industry has significant share of Gross Domestic Product.(Fig.1)
- Annual growth rate of embedded software development cost is on the rise. (Fig.2)
- The size of embedded software is dramatically increasing in recent years. (Fig.3)
- Defective software device is the biggest post-shipment quality issue of embedded software products. (Fig.4)
- Polarization of companies' ability of software quality management. (Fig.5)
- The industry is still grossly understaffed with skilled engineers. (Fig.6)

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Problem Statement

Sustainable profitability under the following situation

Increasing embedded software production
Increasing complexity and functionality
Demand for efficiently in product development
Demand for cost cutting

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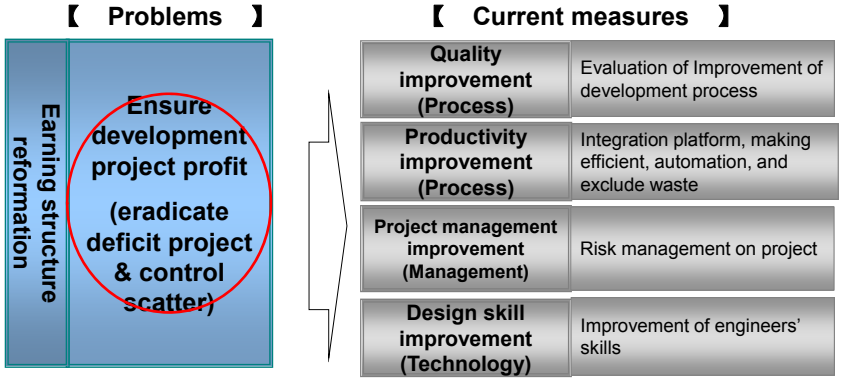
Current measures to deal with problems



We have implemented the above mentioned measures, we do not know the effectiveness of them.

The above mentioned measures by software engineering were considered to remove impossible, variable, and useless on development and contribute to ensure profit by increase efficiency.

However, it is not clear yet how much profit impact do each of these measures have. We considered that we must to show priority of measures clearly by define effectiveness on measures to consider and implement by limited resources.

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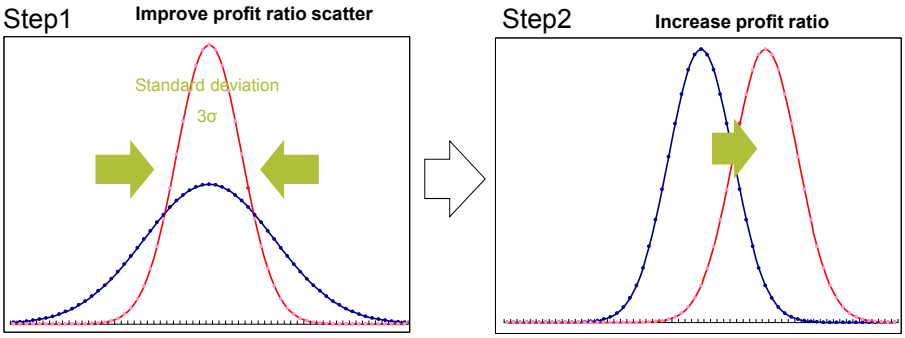
New approach of problem analysis



Step1 (by March, 2014)

- Control the distribution of gross margin ratio in standard deviation **3σ**

Step2 (by March, 2015)

- Increase the gross margin ratio

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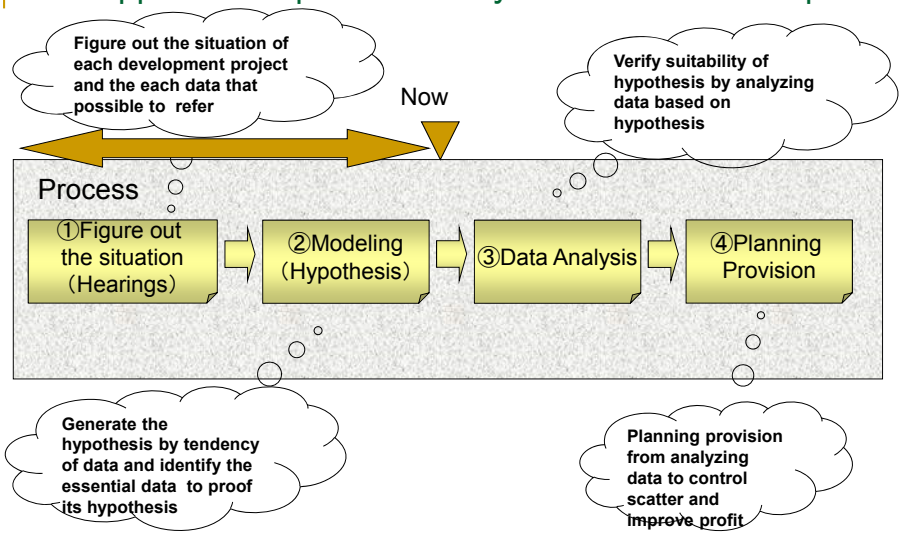
New approach of problem analysis: Process of Step 1



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New approach of problem analysis: What we have done.

- ①Figure out the situation
  - Figure out the situation of each development project and the each data that possible to refer
- ②Modeling (Hypothesis)
  - Identify the factor of varying gross margin ratio by using brainwriting
  - Organize the factors to classify and arrange them and define the hypothesis (Modeling)

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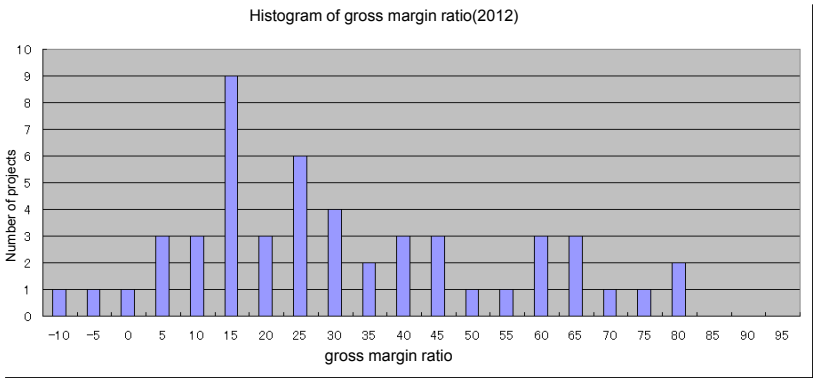
Variation of gross margin ratio



Although, all development projects have same goal (=profit ratio 30%), there are big variation. (standard deviation σ=22.85, skewness =0.48)

The most effect way to solve this problem is to analyze the major factors of big variation on profit ratio and make provision against them.

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Implication of data analysis

In software development, “the variation of profit ratio” means “the variation of project development time”. Therefore, we make a model about the factors of prolonged project development.

From this model, we found that the factors of prolonged project development consist of following below:

- Requirement
- Development process
- Resources (Development engineers)
- Product
- Capacity

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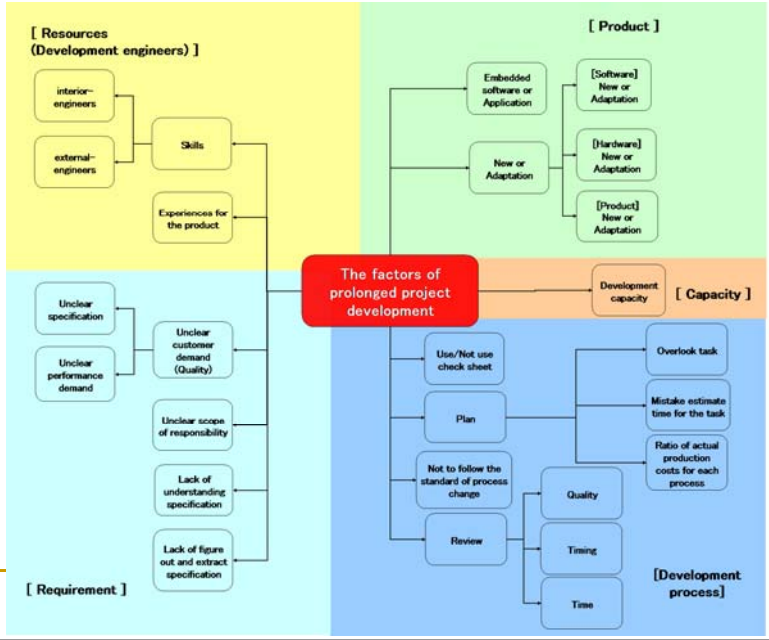
Model of prolonged project development



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Future Research Plan

- ③ Data Analysis
  - Collect the data that is possible to proof hypothesis, from the data on development in year of 2009 – 2013 (on-going)
  - Analyze the collecting data and identify the suitability of hypothesis (on-going)
  - Analyze the relationship between the factors by using Structural Equation Modeling (SEM)
  - Specify the major factor that effect profit ratio the most
- ④ Planning provision
  - Planning and execution of effective provision to reduce variation of profit ratio

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