Division of Research
School of Business Administration

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GLOBAL MANUFACTURING NETWORKS SURVEY

A Preliminary Assessment of Strategic, Operational and Organizational Practices

Working Paper #700

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The University of Michigan

This research report is co-authored by the Co-Directors and Research Associates of the Global Manufacturing Network Project.

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GLOBAL MANUFACTURING NETWORKS

University of Michigan

Introduction

This document contains a summary analysis of the responses to the Global Manufacturing Networks Survey conducted by the University of Michigan Business School in 1991. The survey is part of a larger effort to study the issues and challenges facing firms in managing global manufacturing networks. The questionnaire used for this survey was designed to learn more about these issues. Five different areas were covered: Plant location decisions, Material Flows, Technology transfer, Organizational Systems and Performance. All questions, except those on material flows and organizational systems, were in the form of a 5 point Likert scale. Material flows were expressed in percentages and responses to questions on organizational systems identified the locus of manufacturing decision-making. The following pages contain the summary analysis of the responses to some of the main questions in the survey.

Respondents & Sample Size

The respondents were plant managers in international firms throughout the United States, Europe and Japan. Several key manufacturing industries were covered in the survey. The appendix contains a list of industries and countries covered by the survey.

159 responses were used for this summary analysis. Only responses from plant managers were used for this analysis. Out of the 159 responses 72 responses were from plants built outside the home country. In this sample, 35 plants were owned by European firms, 41 plants by Japanese firms and the rest were US firms.

Analysis Methodology

This document contains the means of the responses to the main questions in each section. The means are presented graphically in the following pages in three forms -- a) the aggregate data, b) comparison of plants located in the home country with those outside the home country, and c) comparison of plants owned by US, European, or Japanese multinationals.

A factor analysis was performed on the responses to group the variables into meaningful factors. The factors, and the variables that comprise these factors are also listed. The grouping of variables into factors suggests relationships between the variables when studied in the context of the questions. The relationships have not been explored further in this analysis.

The intention of this analysis is to provide a summary of the preliminary findings from the questionnaire. A lot of insight is yet to be gained from the rich data set. A more rigorous analysis of the responses is currently in progress.

SECTION II - PLANT LOCATION DECISION

Q1. To what degree did the following factors influence your plant's location decision?

The response to each factor was on a scale from
0: no influence
to 5: very large degree

The factor analysis procedure grouped the variables into seven different sets:

1. Financing & Trade
   - Access to Protected Markets
   - Regional Trade Barriers
   - Government Subsidies
   - Tax Conditions

2. Factor Availability
   - Proximity to Suppliers
   - Access to Raw Materials
   - Access to Low Cost Labor
   - Access to Energy

3. Community Compatibility
   - Language/Culture/Politics
   - Availability of Advanced Infrastructure
   - Exchange Rate Risk

4. Market Base Location
   - Proximity to Customer
   - Proximity to Market

5. Regulatory Environment
   - Environmental Regulations
   - Labor Practices & Regulations

6. Technology Access
   - Access to Local Technology
   - Proximity to other facilities of the Business Unit
   - Access to Capital

7. Labor Requirement
   - Access to skilled labor

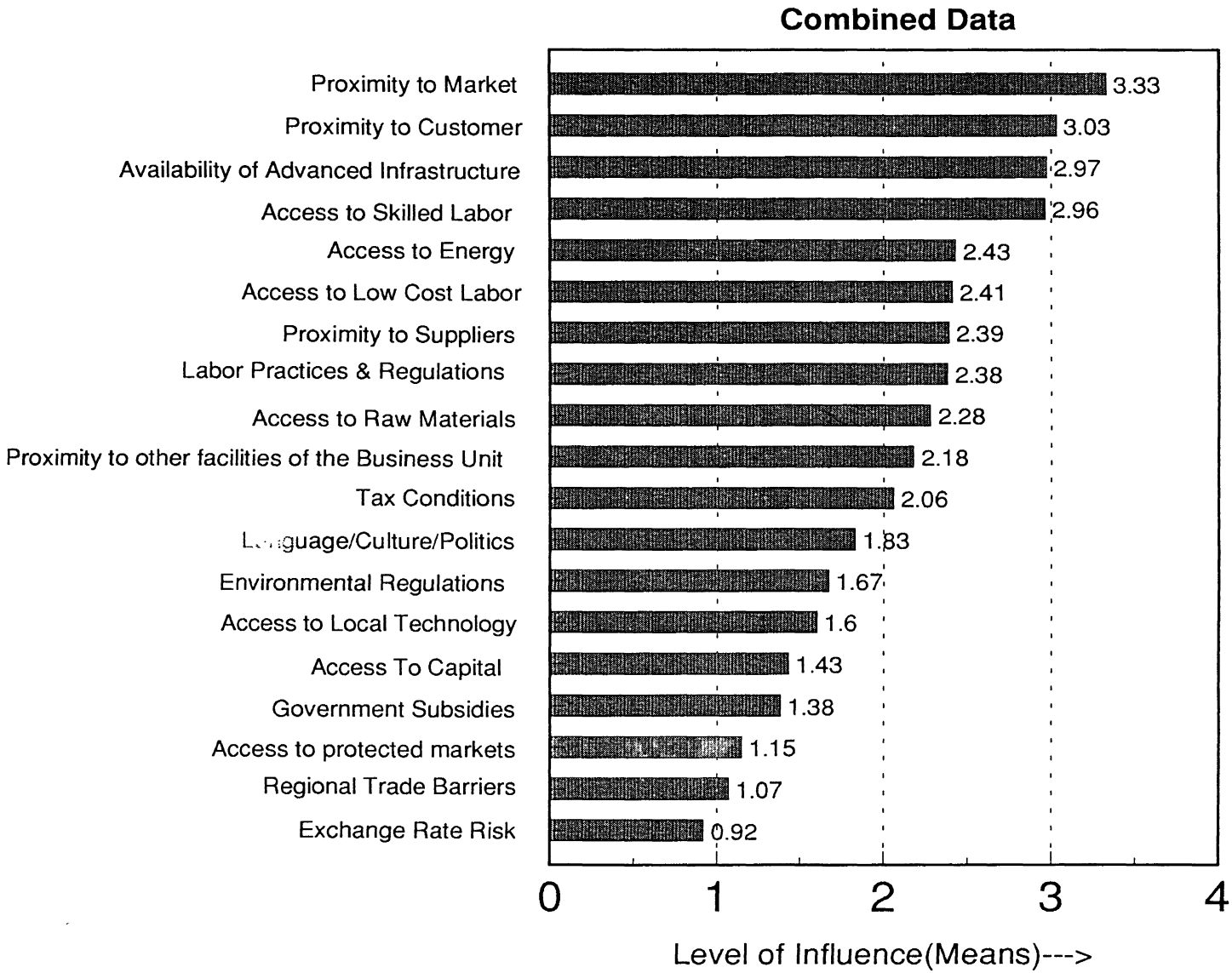
The Proximity to the Customer and the Proximity to the Market (which group into the factor Market Base Location) have a strong influence on the plant location decision. Other variables that have a strong influence are the Availability of Infrastructure and Access to Skilled Labor.

When plants are located in the home country, the data indicates that the Proximity to the Customer and the Market are less important than the Availability of Infrastructure and the Access to Skilled Labor. The reverse is true for plants located outside the home country. Also, not surprisingly, trade issues like Regional Trade Barriers, Exchange Rate Risks, Access to Protected Markets and Government Subsidies, and the Language/Culture/Politics of the region have a larger influence on the location decision for plants away from home.

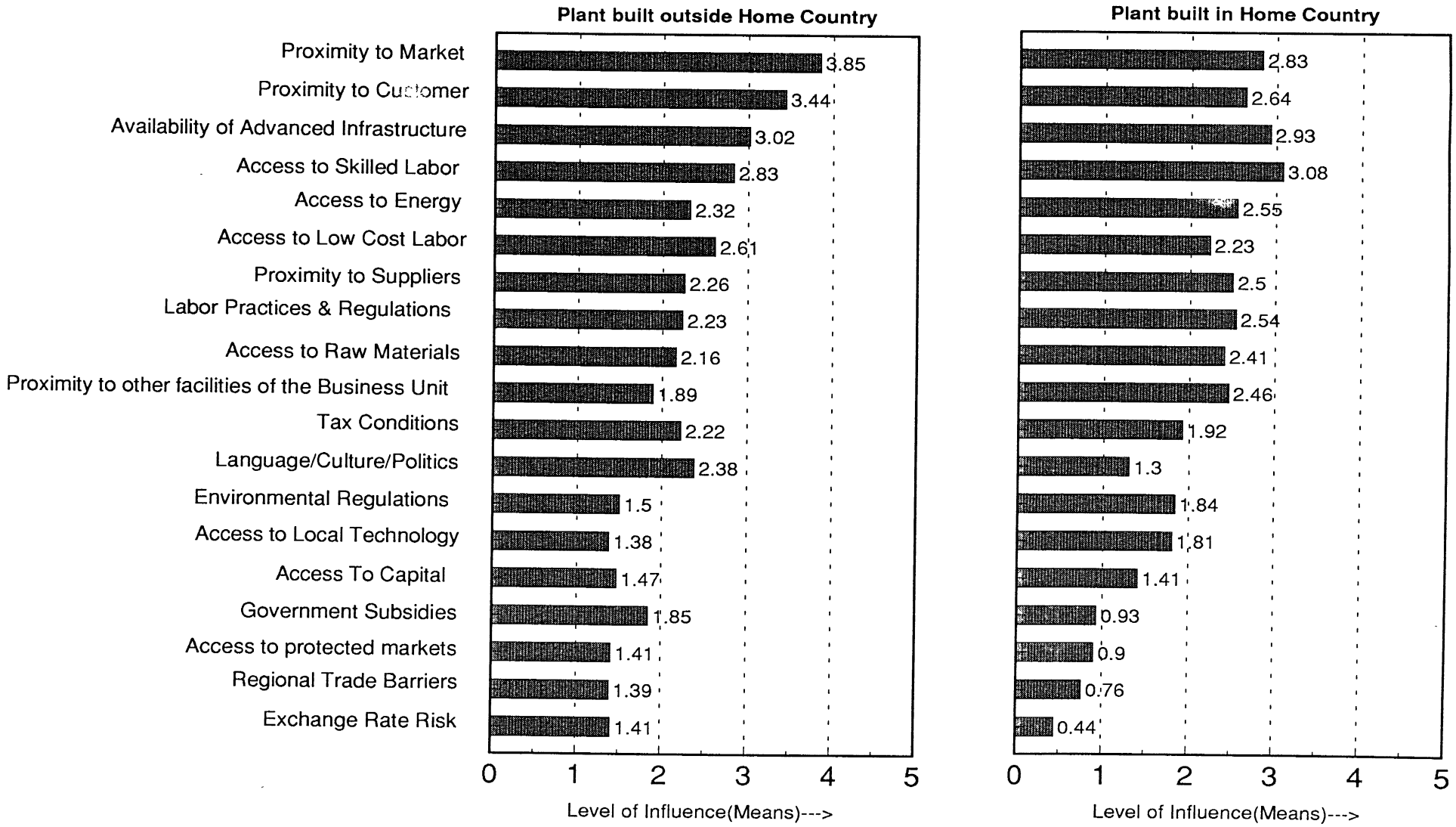
Proximity to Supplier, Access to Raw Materials, and Access to Low Cost Labor (three of the variables in Factor Availability, factor 2) influenced the location decision of Japanese owned plants more than the US and European owned plants. The influence of the regulatory environment was less for Japanese owned plants than for European and the US owned plants.

The means of the observations for the different variables are depicted graphically on the next three pages. Note that the graphs do not group the variables into the factors listed above.

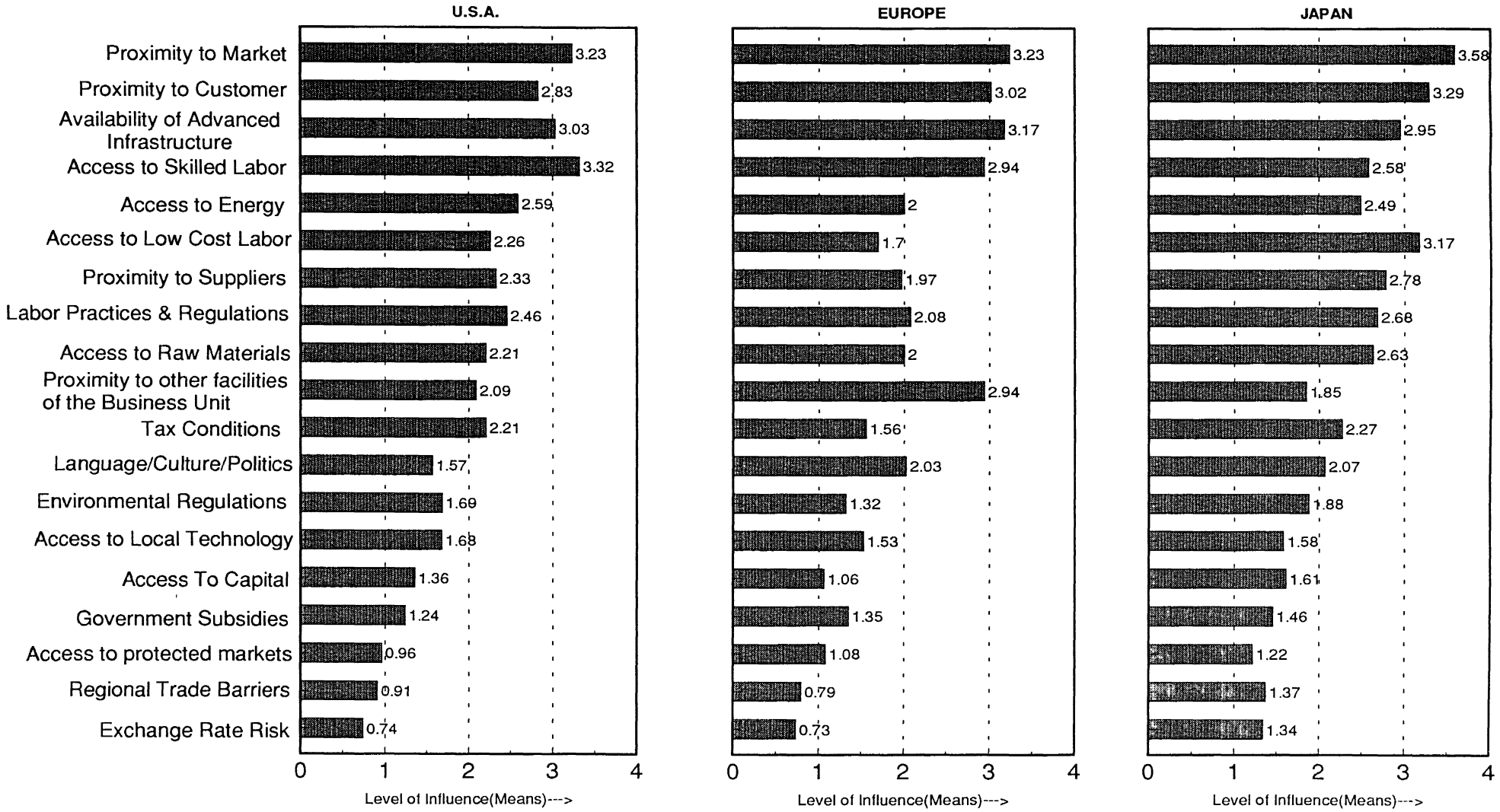
Factors influencing the plant location decision when the plant was built.



Factors influencing the plant location decision when the plant was built (contd.).



Factors influencing the plant location decision when the plant was built - By Region of Ownership



SECTION II - PLANT LOCATION DECISION

Q2. Since your plant was built, conditions may have changed. Please indicate how the following factors would today influence the plant location decision?

The response to each factor was on a scale from
0: no influence
to 5: Very large degree
This question asks the respondent to evaluate the influence of the variables in Question 1 in today's business conditions as opposed to when the plant was built.

The factor analysis on the responses resulted in a grouping of variables slightly different from Question 1, suggesting that the relationships between variables may be different for the decision process today.

1. Financing & Trade
   - Access to Protected Markets
   - Regional Trade Barriers
   - Exchange Rates
   - Access to Local Technology
   - Access to Capital

2. Factor Availability
   - Proximity to Suppliers
   - Access to Raw Materials
   - Environmental Regulations (possibly meaning access to waste disposal facilities)
   - Access to Energy
   - Access to Skilled Labor

3. Community Compatibility
   - Language/Culture/Politics
   - Availability of Advanced Infrastructure
   - Labor practices/regulations

4. Market Base Location
   - Proximity to Customer
   - Proximity to Market

5. Government Incentives
   - Tax Conditions
   - Government Subsidies

6. Labor Requirements
   - Access to Low Cost Labor

7. Proximity to other facilities of the Business Unit

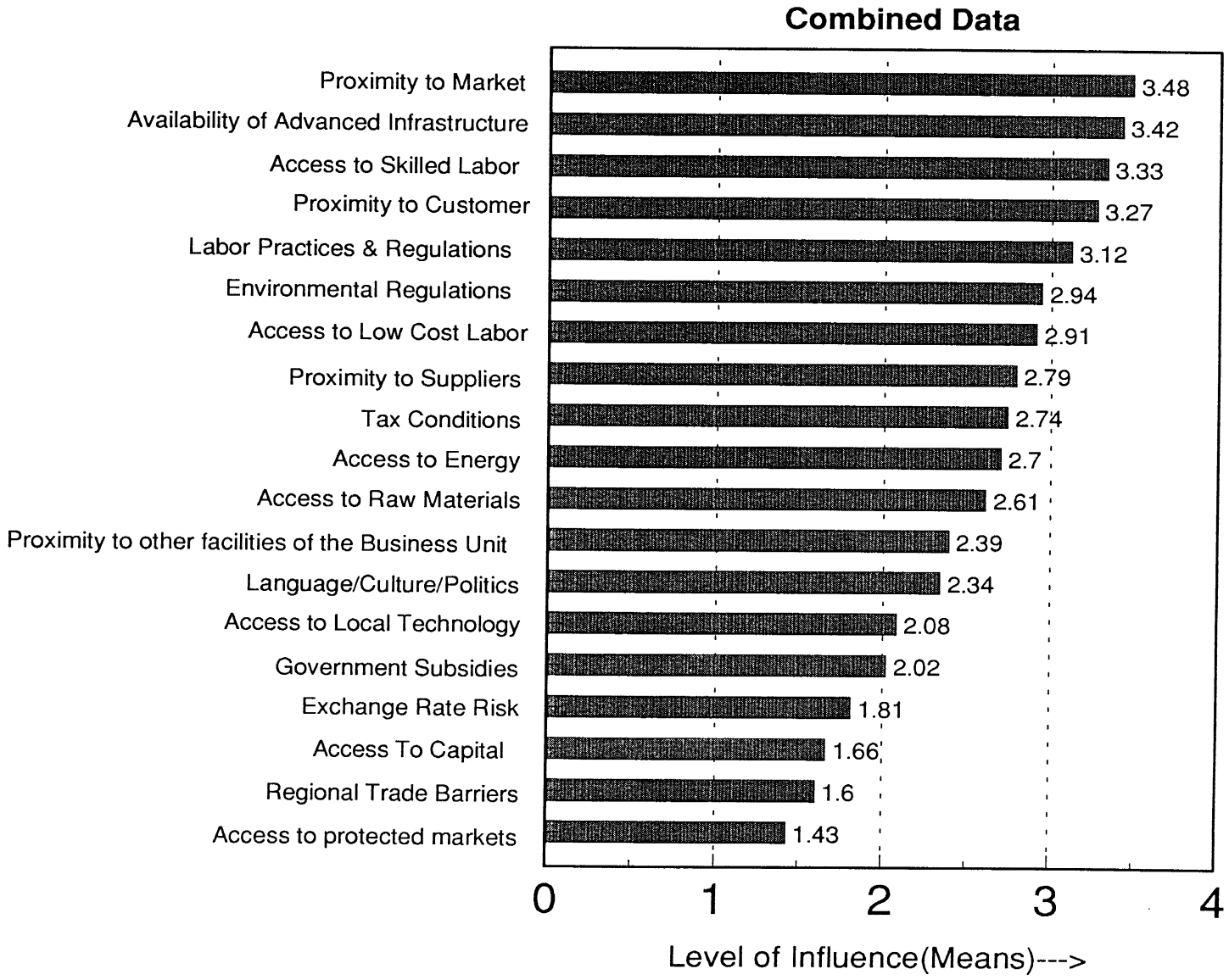
In the factor analysis, while four out of seven factors were almost identical to the factors in Question 1, Tax Conditions and Government Subsidies grouped to form a factor we have termed Government Incentives. Also, while Access to Skilled Labor was a separate factor in the previous case, Access to Low Cost Labor separated as a factor for this question (note that access to skilled labor is still a bigger influence on the location decision).

The Proximity to the Customer and the Market, and the Availability of Infrastructure are still the dominant influences in the plant location decision.

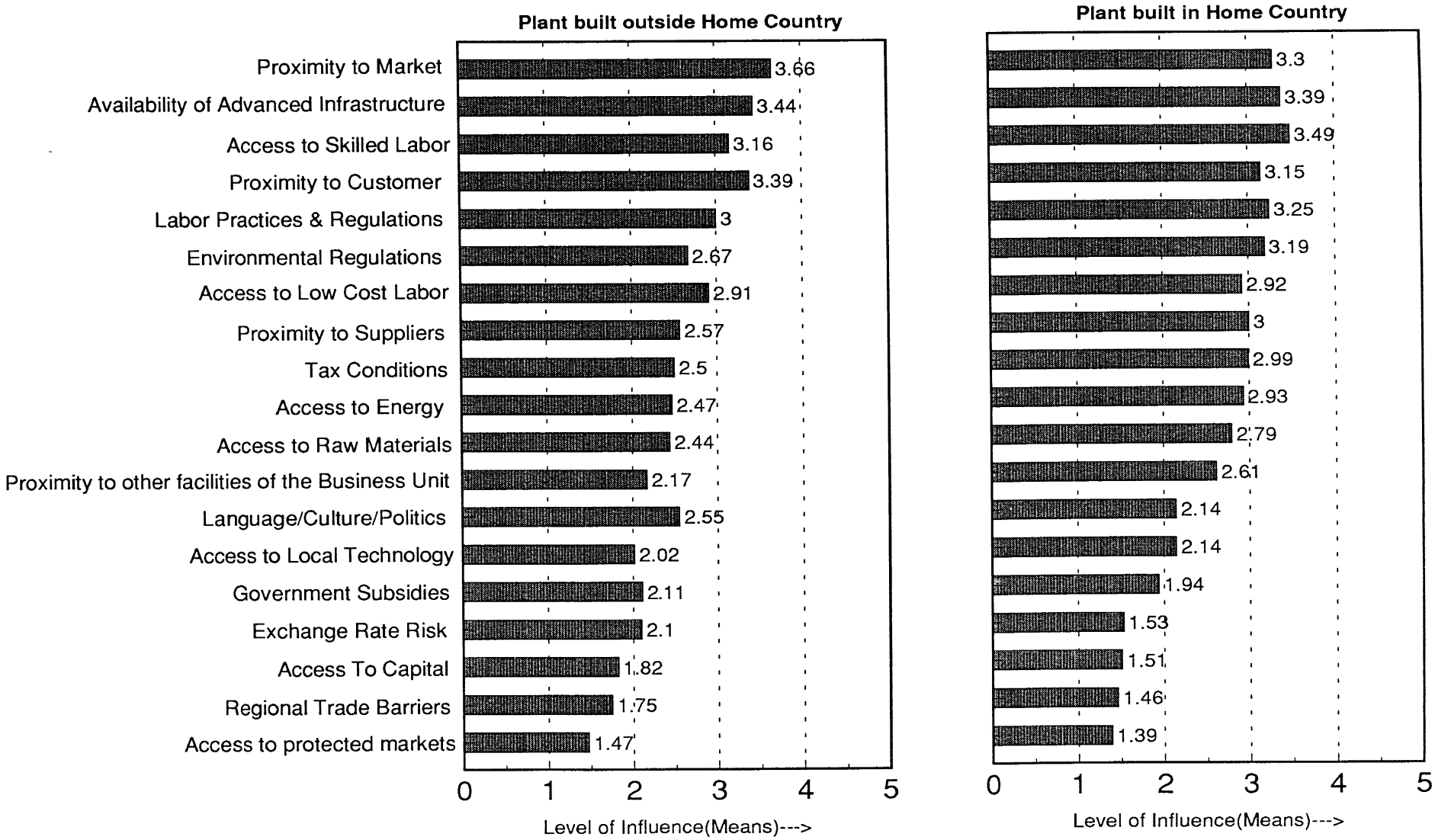
The variables related to trade issues such as Regional Trade Barriers and Exchange Rate Risk, and variables indicative of access to the market and customer recorded higher means for the location decision for plants built outside the home country.

While Access to Skilled Labor was considered more important to US and European owned plants, the Japanese plants placed an emphasis on low cost labor. Labor Practices & Regulations also seem to have a larger influence on the location decision of US owned plants. European owned plants considered the Access to other facilities of the Business Unit more important in today's location decision than US or Japanese owned plants.

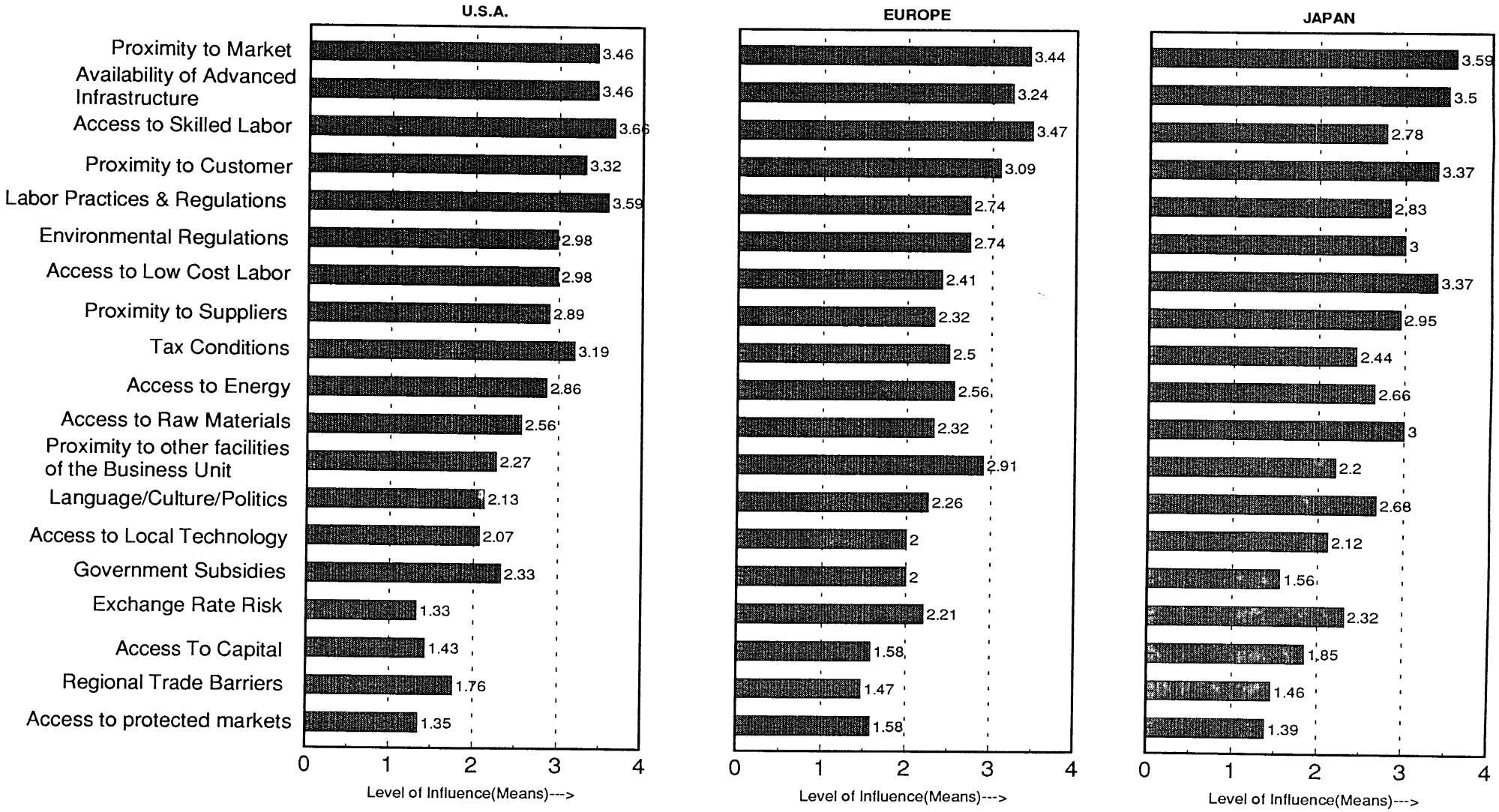
Factors influencing the plant location decision if the plant were built today.



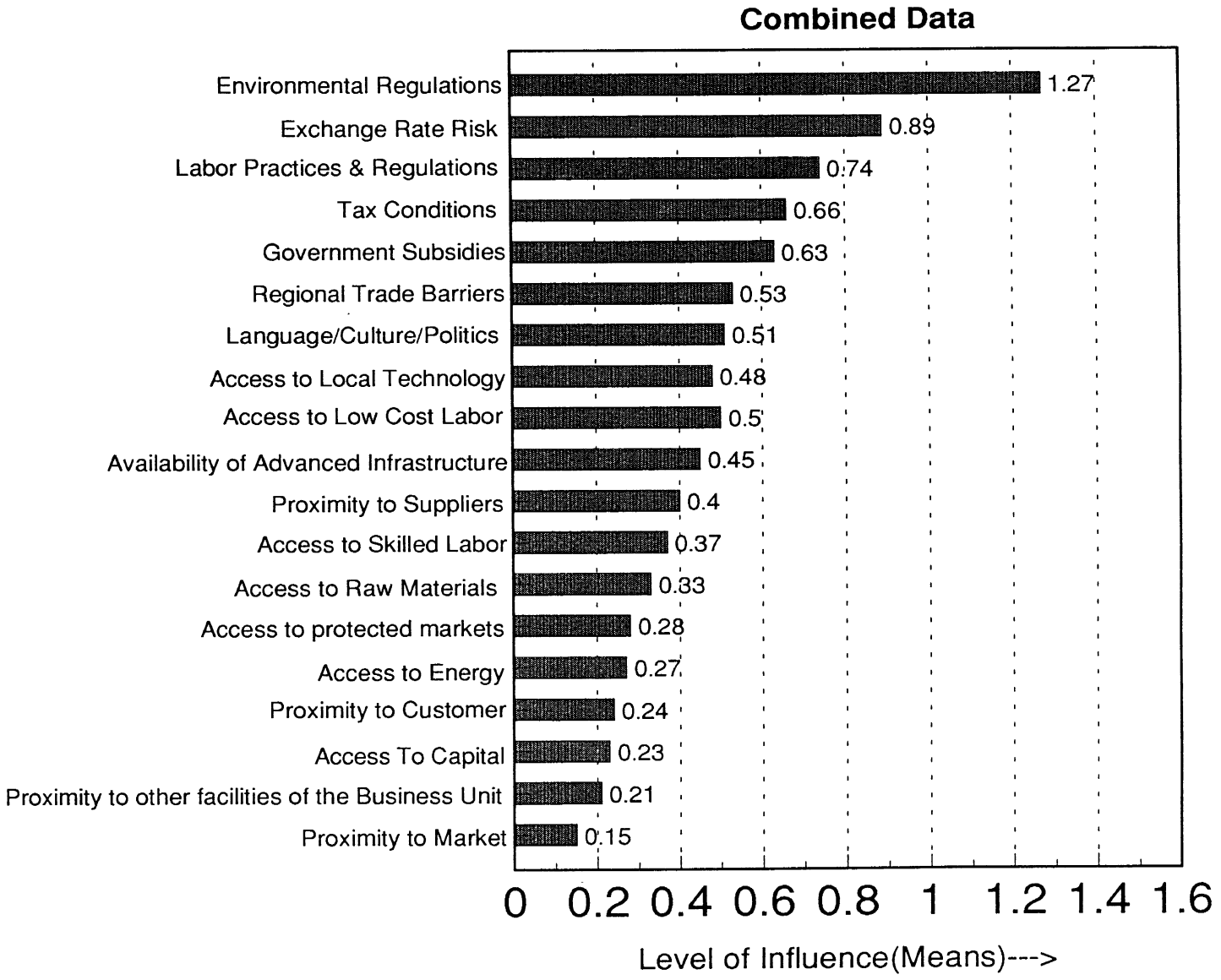
Factors influencing the plant location decision if the plant were built today (contd.).



Factors influencing the plant location decision if the plant were built today - By Region of Ownership



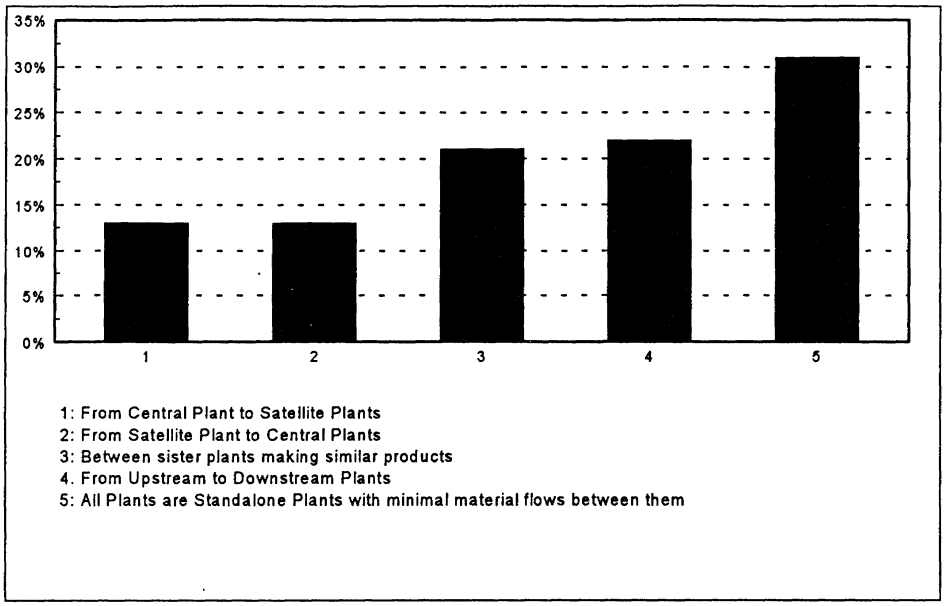
Difference in the Influence of a Factor on the Location Decision Today vs. When The Plant was Built.



SECTION III - MATERIAL FLOWS

Q1. Which of the following best describes the material flows among the plants in your business unit?

Aggregate Data



By SIC Code

	From central plant to satellite plants	From satellite plants to central plants	Between sister plants making similar products	From upstream to downstream plants	All plants are standalone plants with minimal material flows between plants
Food & Kindred Products SIC 20	sample too small				
Paper & allied Products SIC 26	sample too small				
Chemicals & Allied Products SIC 28	11.00%	3.00%	13.00%	31.00%	42.00%
Industrial & Commercial Machinery & Computer Equipment SIC 35	4.00%	8.00%	52.00%	12.00%	24.00%
Electronic & Electrical Equipment & Components except Computer Equipment SIC 36	17.00%	16.00%	17.00%	33.00%	17.00%
Transportation Equipment SIC 37	11.00%	27.00%	24.00%	13.00%	24.00%
Meas., Analyzing & Controlling Instr.;Photographic Medical & Optical goods; Watches & Clocks SIC 38	20.00%	10.00%	0.00%	20.00%	50.00%
Miscellaneous Manufacturing Industries SIC 39	sample too small				

Q3, Q5. Indicate the current sources of material inputs/outputs to/from your plant.

The sources and destinations were company owned plants, customers and suppliers, both within the country and outside the country. The following percentages are calculated from the data:

Export-Import : TO[Company owned plants and customers outside the country] - FROM[Company owned plants and suppliers outside the country]

Material Inflow: Inflow FROM Company owned plants

Material Outflow: Outflow TO Company owned plants

	Export-Import	Material Inflow	Material Outflow
Food & Kindred Products SIC 20	sample too small		
Paper & allied Products SIC 26	-20%	94%	86%
Chemicals & Allied Products SIC 28	3%	73%	70%
Industrial & Commercial Machinery & Computer Equipment SIC 35	-20%	67%	71%
Electronic & Electrical Equipment & Components except Computer Equipment SIC 36	1%	69%	73%
Transportation Equipment SIC 37	5%	67%	60%
Meas., Analyzing & Controlling Instr.;Photographic Medical & Optical goods; Watches & Clocks SIC 38	-2%	55%	78%
Miscellaneous Manufacturing Industries SIC 39	sample too small		

Q4, Q6, Indicate how the current sources of material inputs/outputs to/from your plant are changing.

	Percentage of responses indicating an...		
	Increase	Decrease	No Change
From Company Owned Plants in your country	25%	30%	45%
To Company Owned Plants in your country	41%	24%	35%
From Company Owned Plants Outside your country	36%	34%	40%
To Company Owned Plants Outside your country	25%	48%	27%
From External Suppliers Inside your country	37%	37%	26%
To External Customers Inside your country	35%	30%	35%
From External Suppliers Outside your country	32%	47%	21%
To external Customers Outside your country	14%	62%	24%

SECTION IV - TECHNOLOGY TRANSFER

Q1. Please indicate to what extent each of the following possible sources of technology play a role in your business unit.

The response to each factor was on a scale from
0: no role
to 5: very large extent

PRODUCT TECHNOLOGY

The factor analysis produced five separate factors.
1. Hired External Consultants
   Consulting Organizations
   Research & Educational Institutions
   Government

2. External Sources (difficult to access)
   Competitors
   Customers

3. Internal Sources
   Plant level R&D, manufacturing, engineering,...
   Work Force

4. Suppliers

5. Corporate Sources
   Business Unit level R&D, manufacturing, engineering.

The main sources of technology were identified as Business Unit R&D, manufacturing, engineering facilities followed by the same resources at the plant level. Workforce, Customers and Suppliers were also considered to be important sources of product technology. For plants located at home, Customers also served as a prominent source of product technology.

Little difference exists between the regions with the exception that US and Japanese plants rate the Suppliers as a source of technology higher than the European plants.

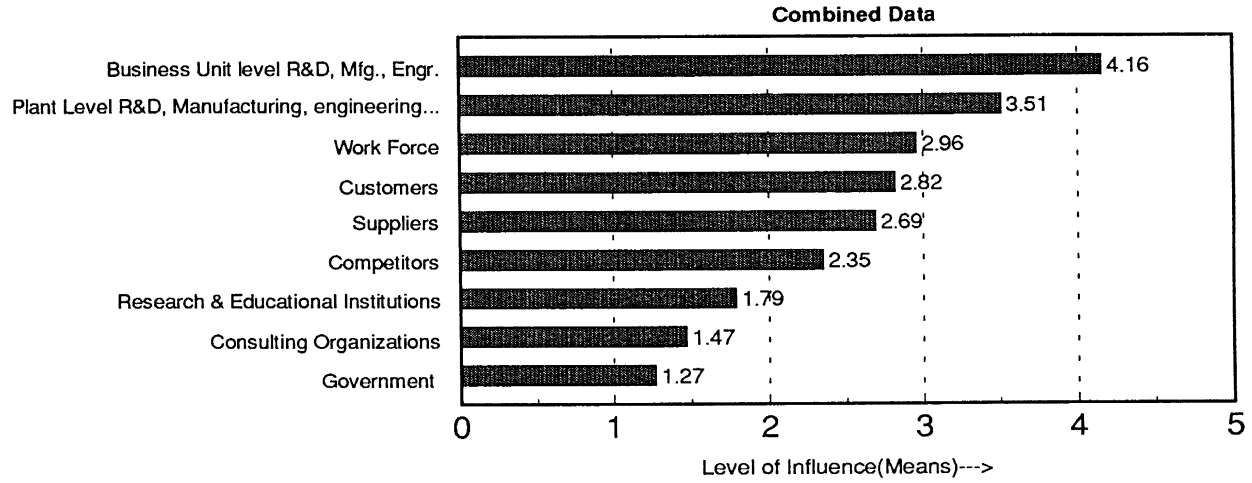
PROCESS TECHNOLOGY

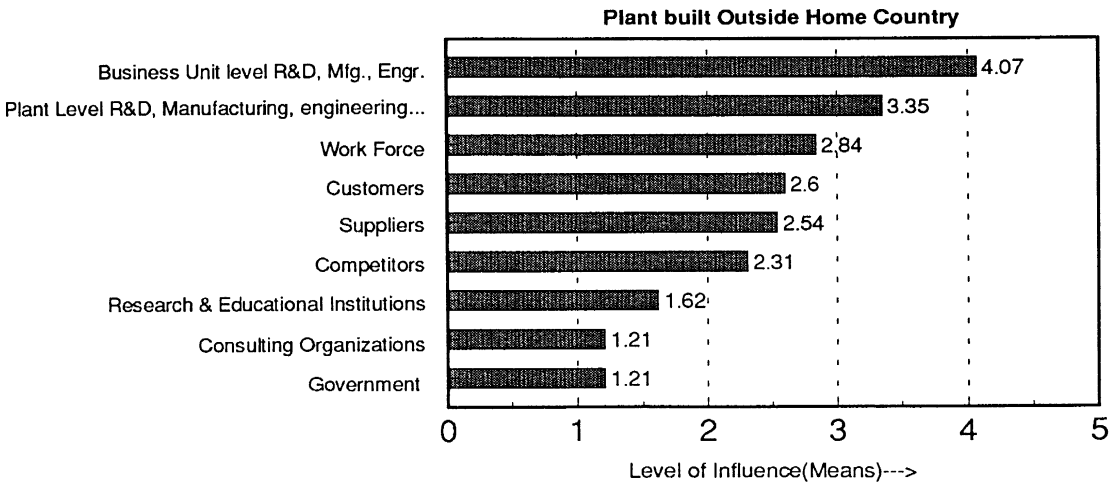
Though the factor analysis produced a set of factors identical to those for Product Technology, four variables:

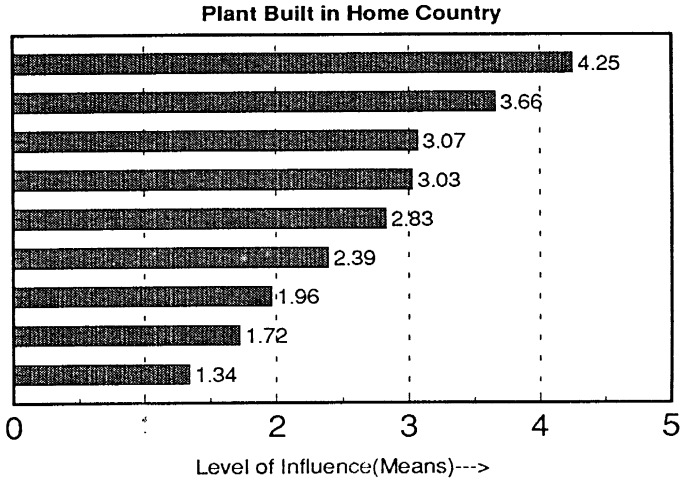
- Plant Level R&D, manufacturing, engineering...
- Work Force
- Business Unit Level R&D, manufacturing, engineering...
- Process Equipment Suppliers

were very dominant sources of process technology. Again, there was very little difference in the means of these variables when compared based on location at home or outside, and when compared by Japanese, US or European ownership.

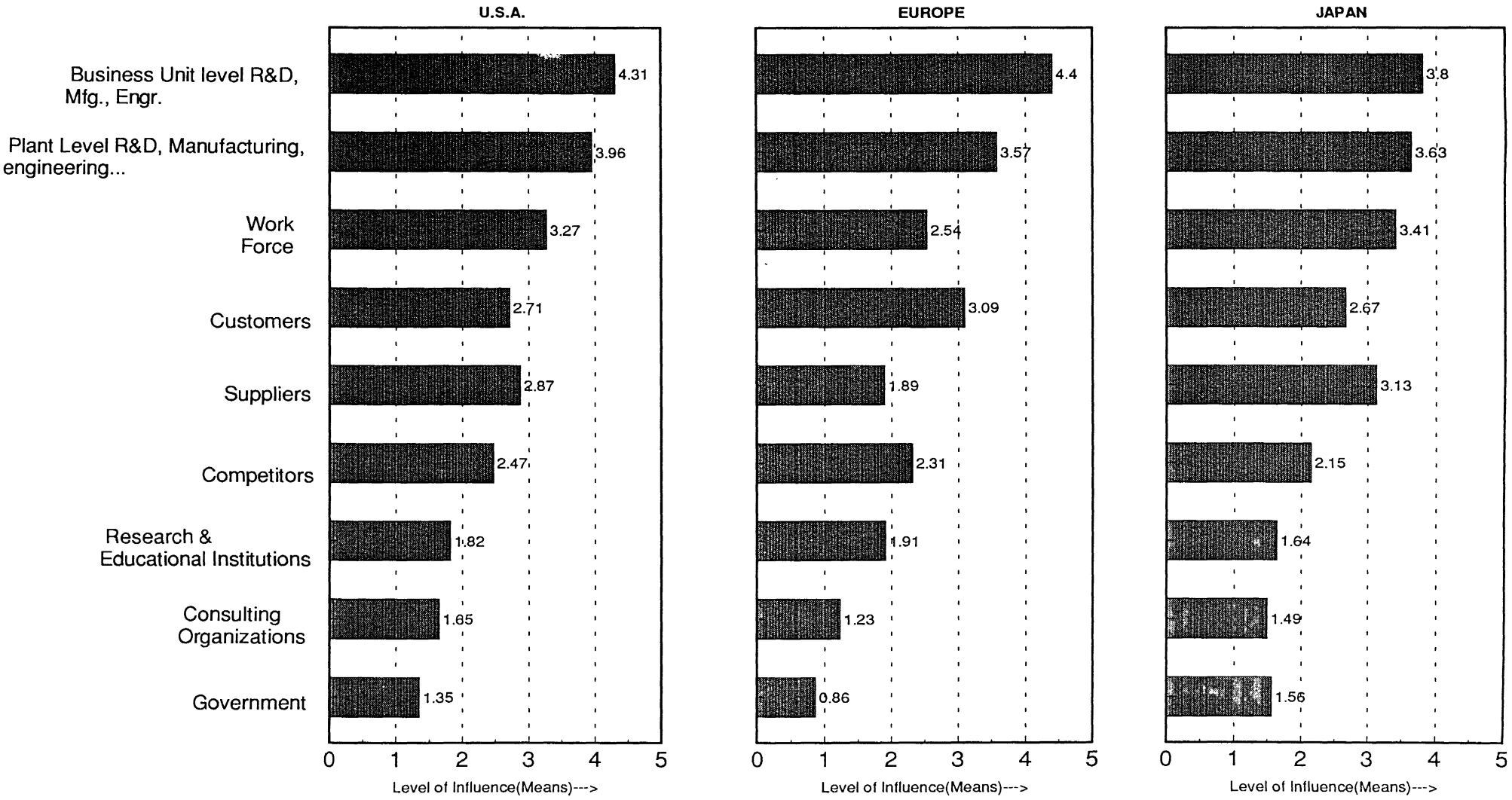
Main Sources of Product Technology



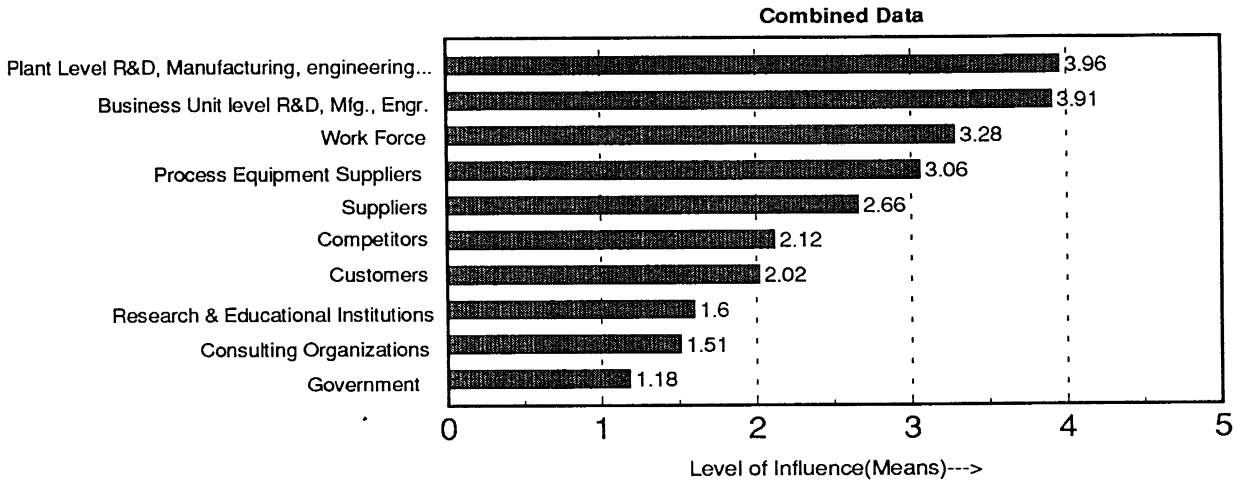


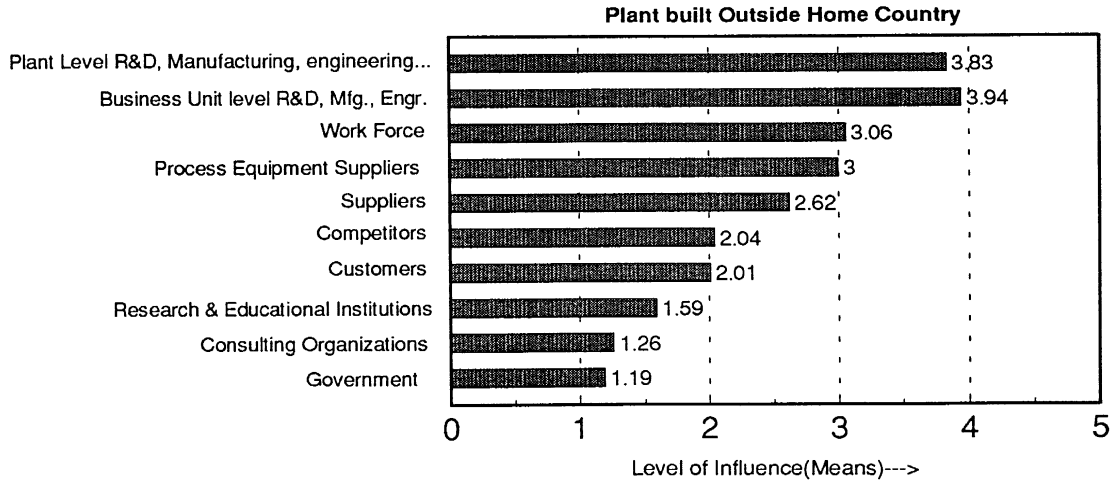


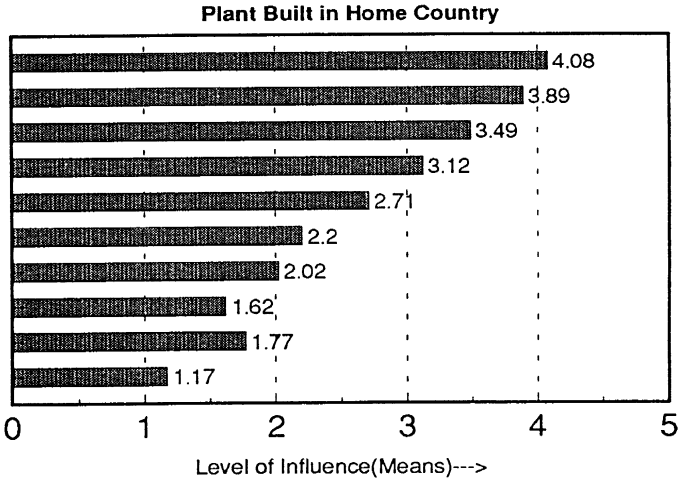
Main sources of Product Technology - By Region of Ownership



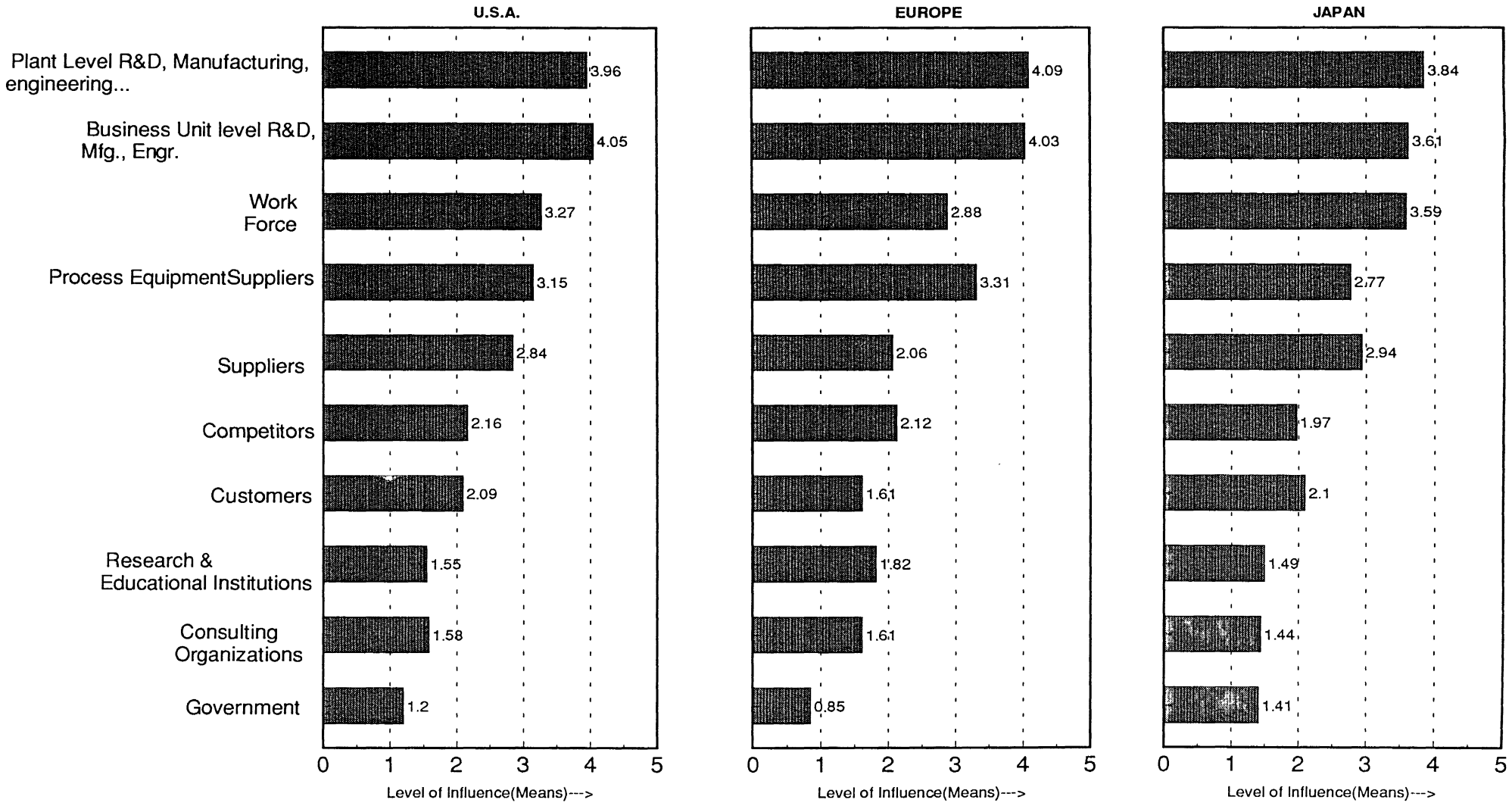
Main Sources of Process Technology







Main sources of ProcessTechnology - By Region of Ownership



SECTION IV - TECHNOLOGY TRANSFER

Q2. To what extent are the following methods used for accomplishing technology transfer in your business unit?

The response to each factor was on a scale from
0: not used
to 5: used to a very large extent

The factor analysis grouped the data into four groups

1. Technology Transfer Events
   Formal Training
   Project Teams & Task Force
   Internal Documentation
   Short-term reassignment of Personnel

2. Ongoing Diffusion
   Scientific and Engineering meetings
   Long-term Personnel transfers

3. Facilitating Devices
   External Consultants
   CAD/CAM Systems

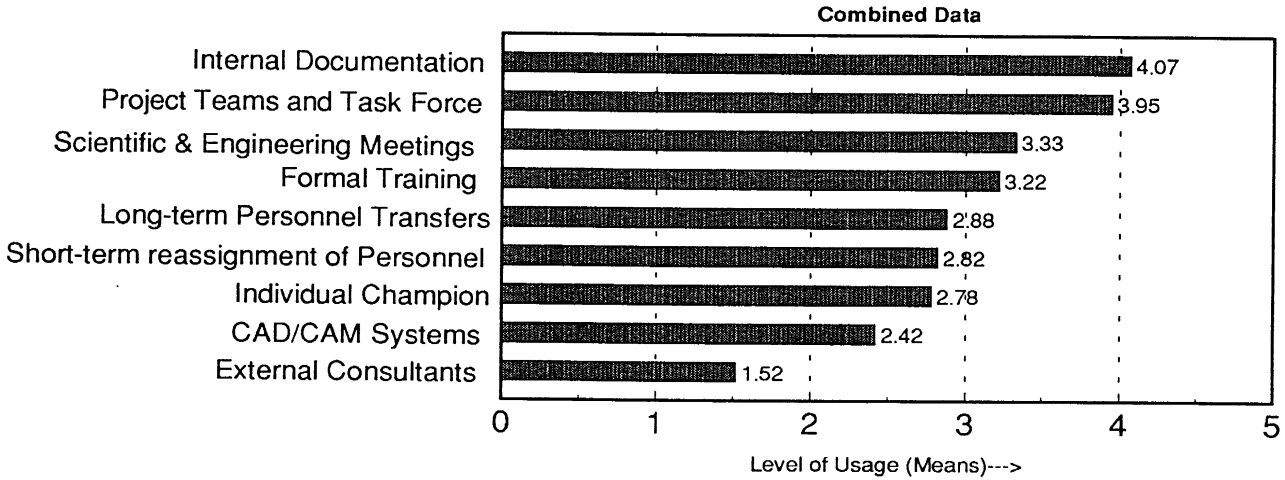
4. Individual Champion

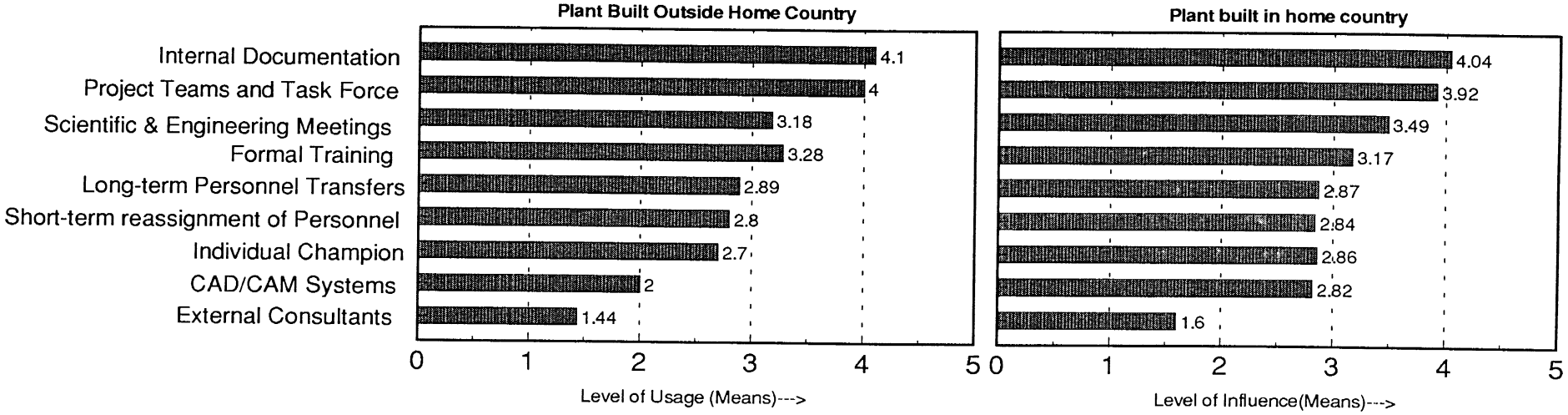
Internal Documentation and the use of Project Teams & Task Forces were the two most commonly used methods for technology transfer. These two methods remain dominant when the data is divided based on plant location or by ownership. The data indicates that facilitating devices such as CAD/CAM or the use of external consultants contribute least to the transfer of technology.

For the Japanese owned plants, the use of an Individual Champion to transfer technology is noticeably lower than the European and US plants and the use of Internal Documentation is higher.

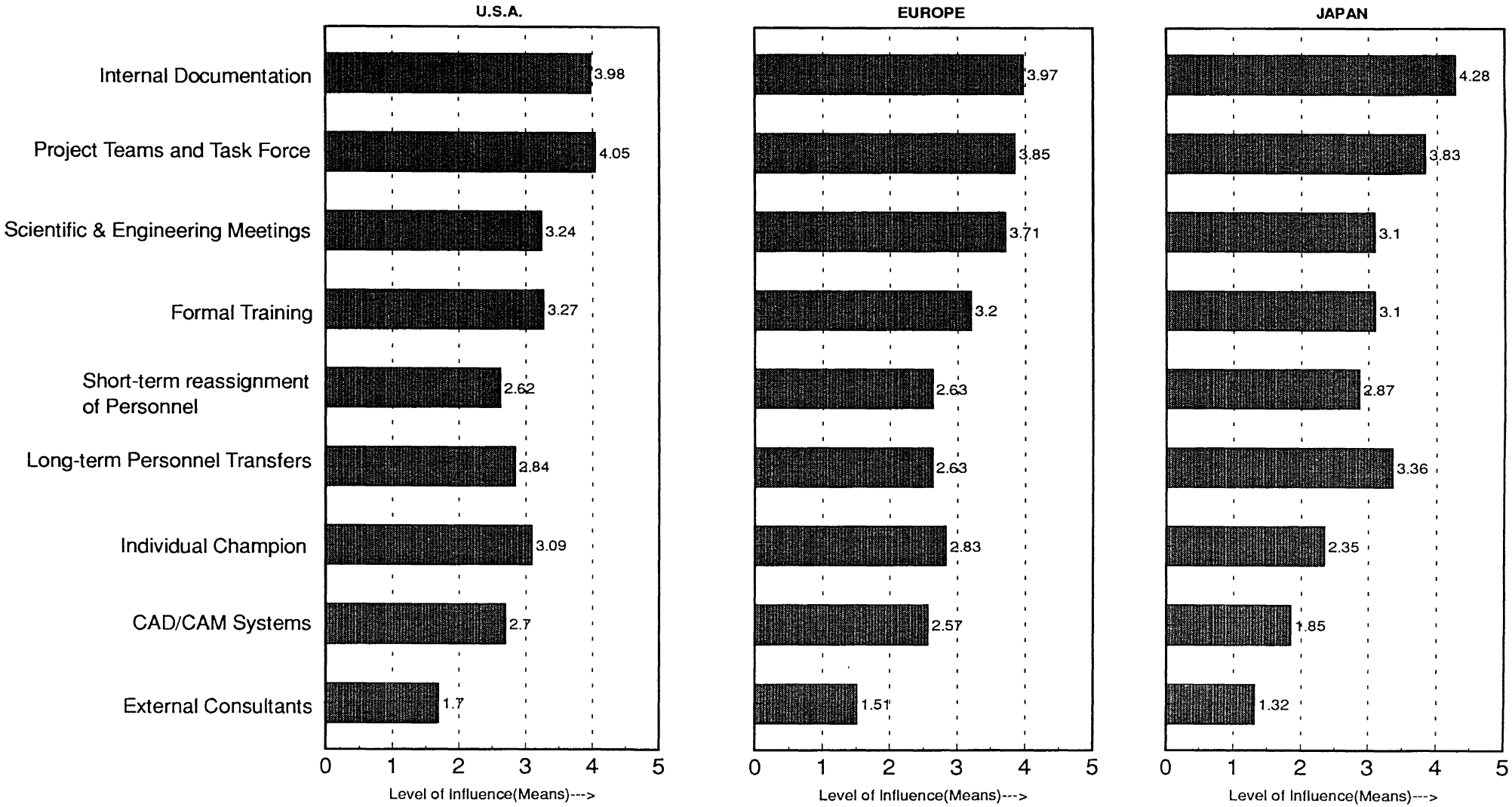
The most dominant factor is Technology Transfer Events (factor1) suggesting that most technology transfer is done with planned events rather than on a continuous basis.

Technology Transfer Methods





Technology Transfer Methods -- By Region of Ownership



SECTION IV - TECHNOLOGY TRANSFER

Q6. What is the extent of standardization across plants in your business unit?

The response to each factor was on a scale from
0: no role
to 5: very large extent

The factor analysis grouped the variables into the following factors:

1. Control Systems(operational/tactical)
   Cost Accounting systems
   Personnel Practices & Policies
   Production Planning & Control
   Quality Control Systems

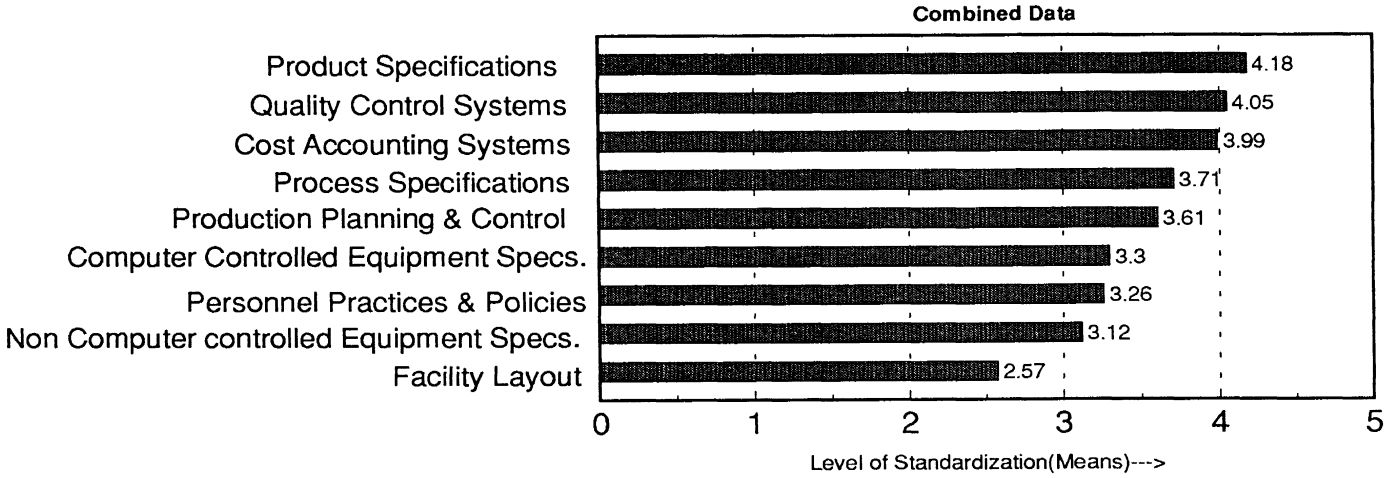
2. Procurement Standards (corporate involvement)
   Non computer controlled equipment specifications
   Computer controlled equipment specifications
   Facility layout

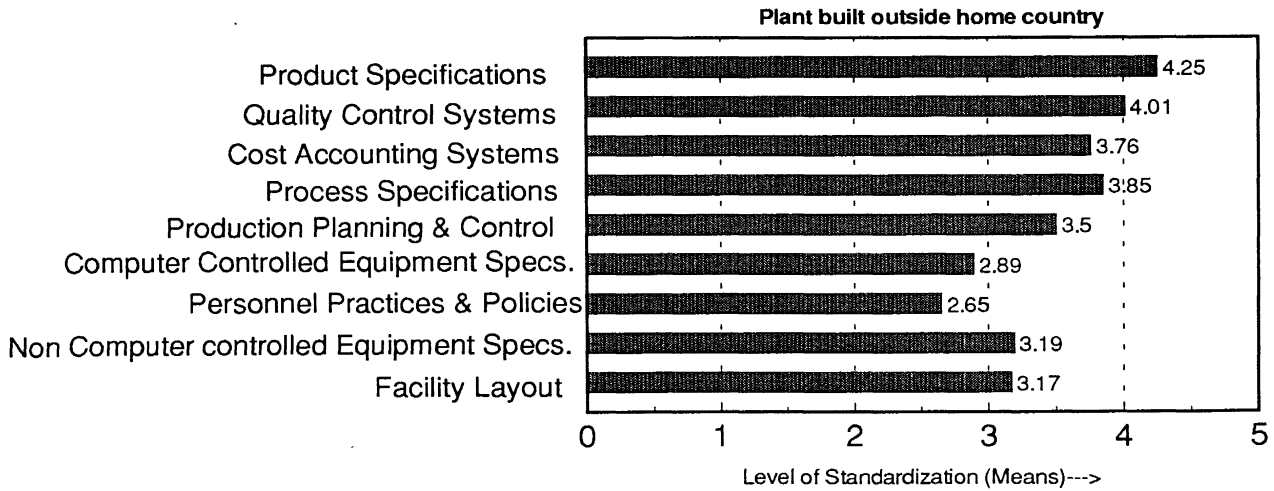
3. Customer Standards (market driven)
   Product specifications
   Process Specifications

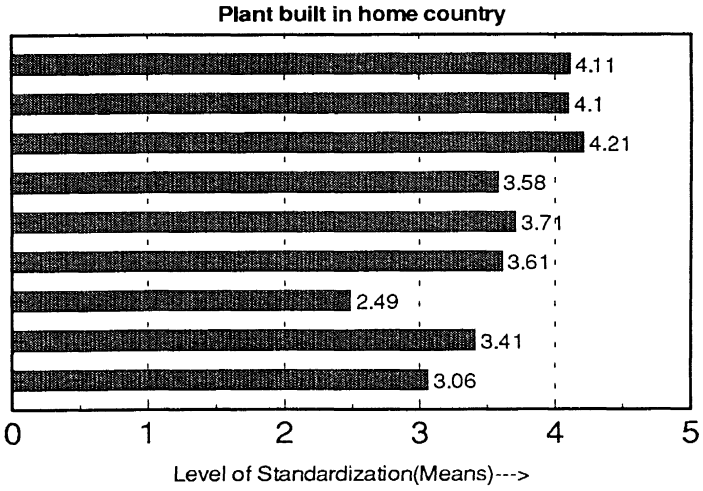
The level of standardization was highest for Control Systems, the factor which includes Cost Accounting Systems and Quality Systems among others. Customer Standards, i.e. Process and Product Specifications also had a high level of standardization.

When compared by ownership, Personnel Practices are less standardized for European and Japanese plants than for the US plants. The data indicates that Facility Layouts are more standardized for Japanese owned plants.

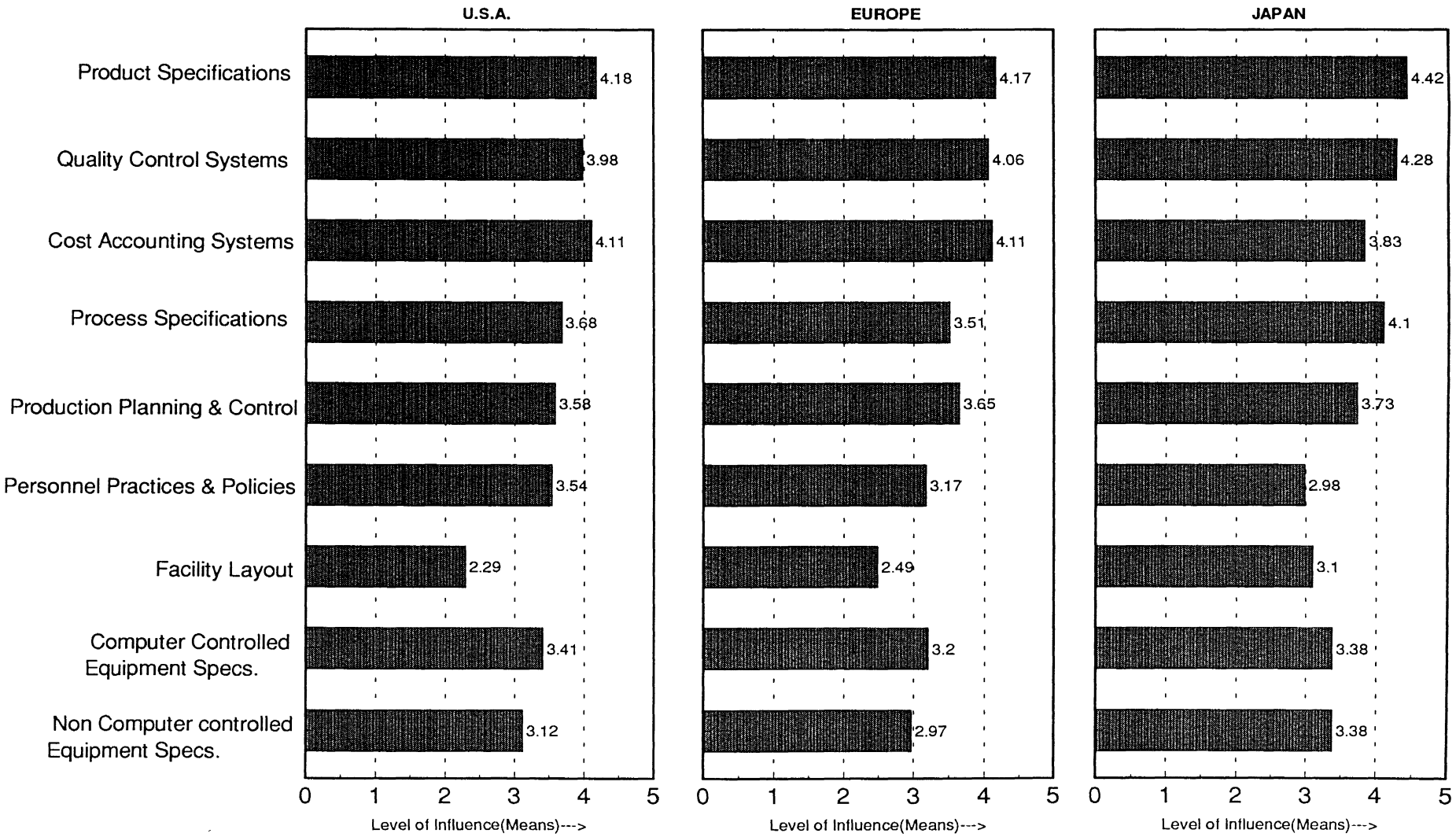
Extent of Standardization in the plants.







Extent of Standardization in the Plants -- By Region of Ownership



SECTION V - ORGANIZATIONAL SYSTEMS

Q6. To what extent do the following factors contribute to achieving coordination/integration of manufacturing operations across plants in your business unit?

The response to each factor was on a scale from
0: doe not contribute
to 5: contributes to a very large extent

The factor analysis grouped the responses into the following factors.

1. Homogenization
   - Process standardization
   - Product standardization
   - Technology transfer form Business Unit HQ / Central R&D
   - Common Quality Standards across plants
   - Technology transfer across plants in the Business Unit

2. Duplication
   - Similar Cost Accounting systems
   - Similar Production Planning systems

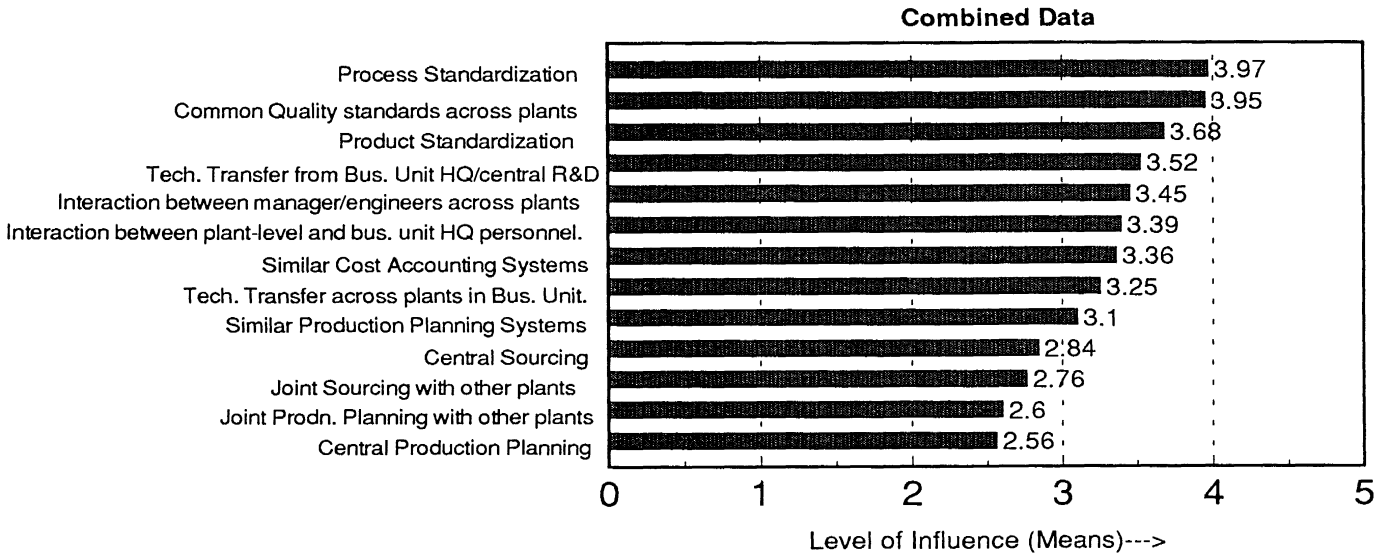
3. Centralization
   - Central sourcing
   - Central production planning

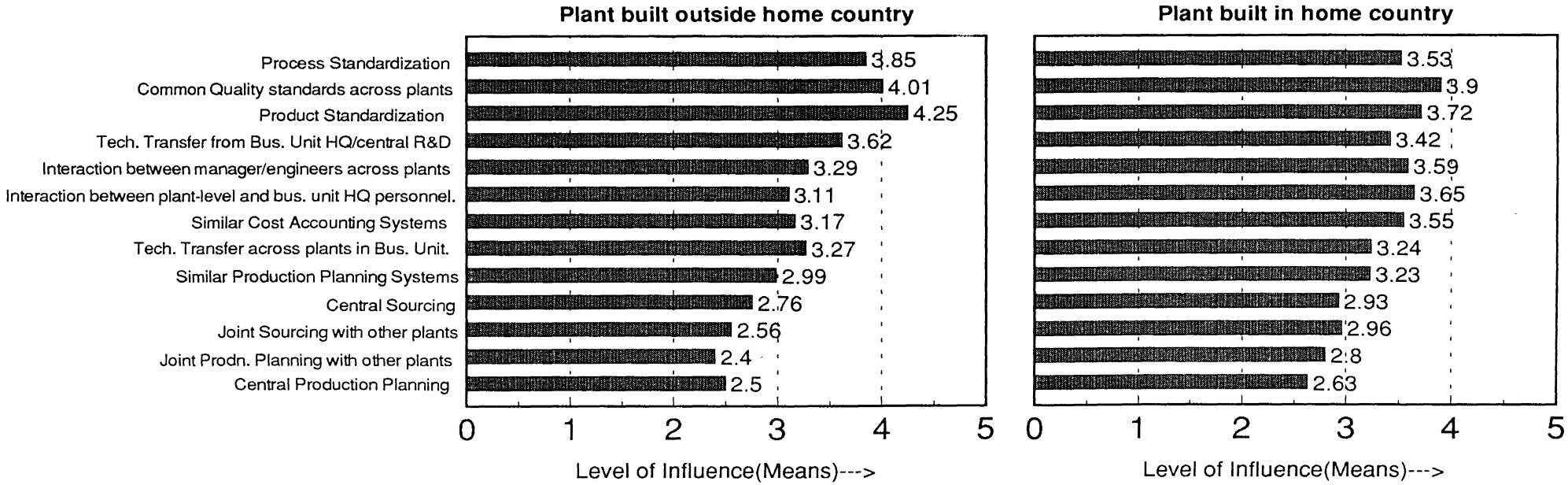
4. Co-operation
   - Joint sourcing with other plants
   - Joint production planning with other plants

5. Personnel Interaction
   - Interaction between plant-level and Business Unit HQ personnel
   - Interaction between managers/engineers across plants

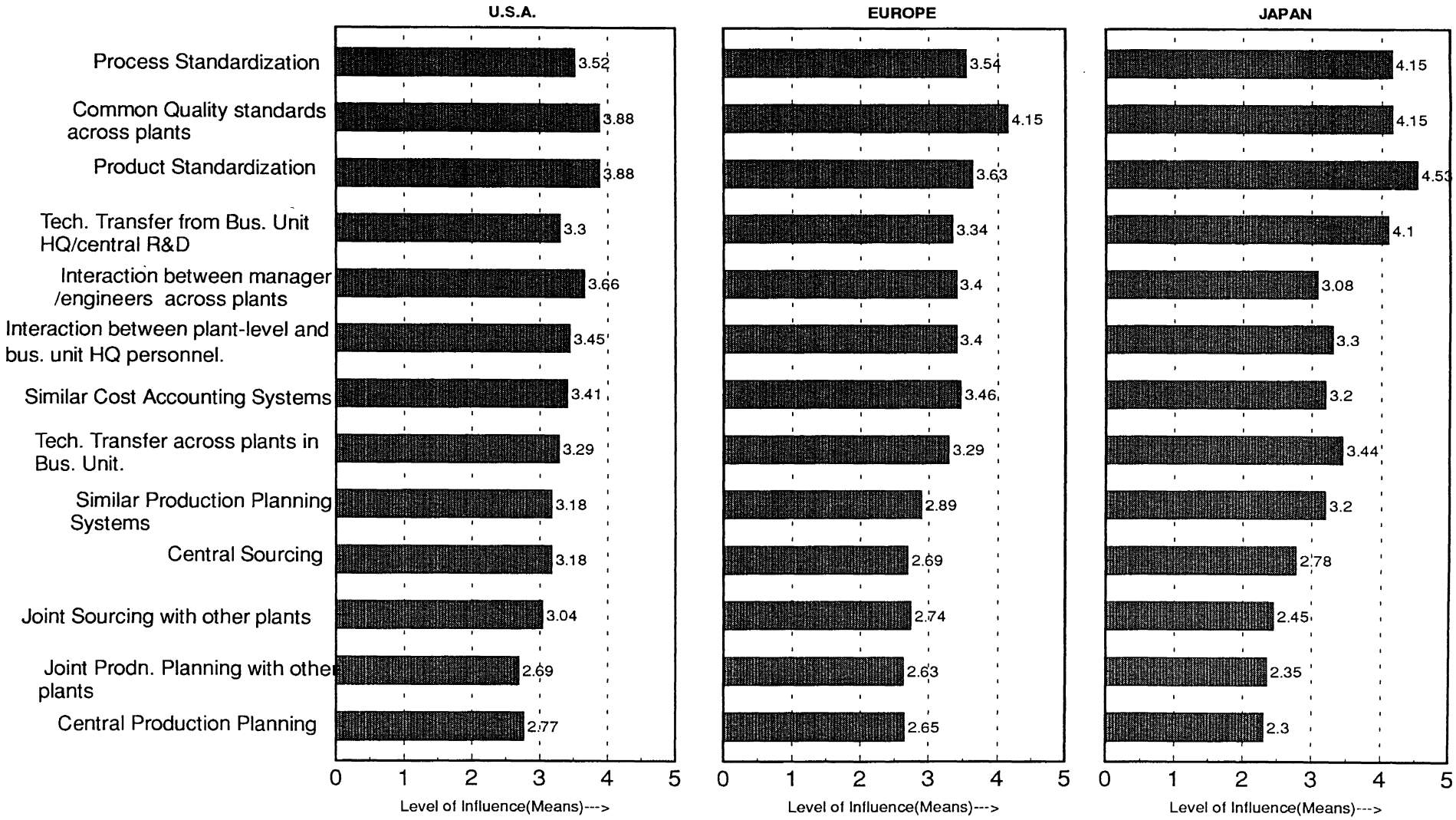
The responses with the highest means for the aggregate data were for Process Standardization and Common Quality Standards. Plants built outside the home country viewed Product Standardization as the largest contributor to technology transfer. Japanese plants responded with noticeably higher scores for process and product standardization, and technology transfer from HQ than the European and US plants.

Factors Contributing to Coordination & Integration.





Factors Contributing to Coordination & Integration -- By Region of Ownership



SECTION V - ORGANIZATIONAL SYSTEMS

Q1. Who has the primary responsibility for the following tasks for your plant?

The following were possible responses to the question
0: don't know/ not sure
1: worldwide headquarters
2: regional headquarters
3: another plant
4: your plant in coordination with another plant
5: your plant

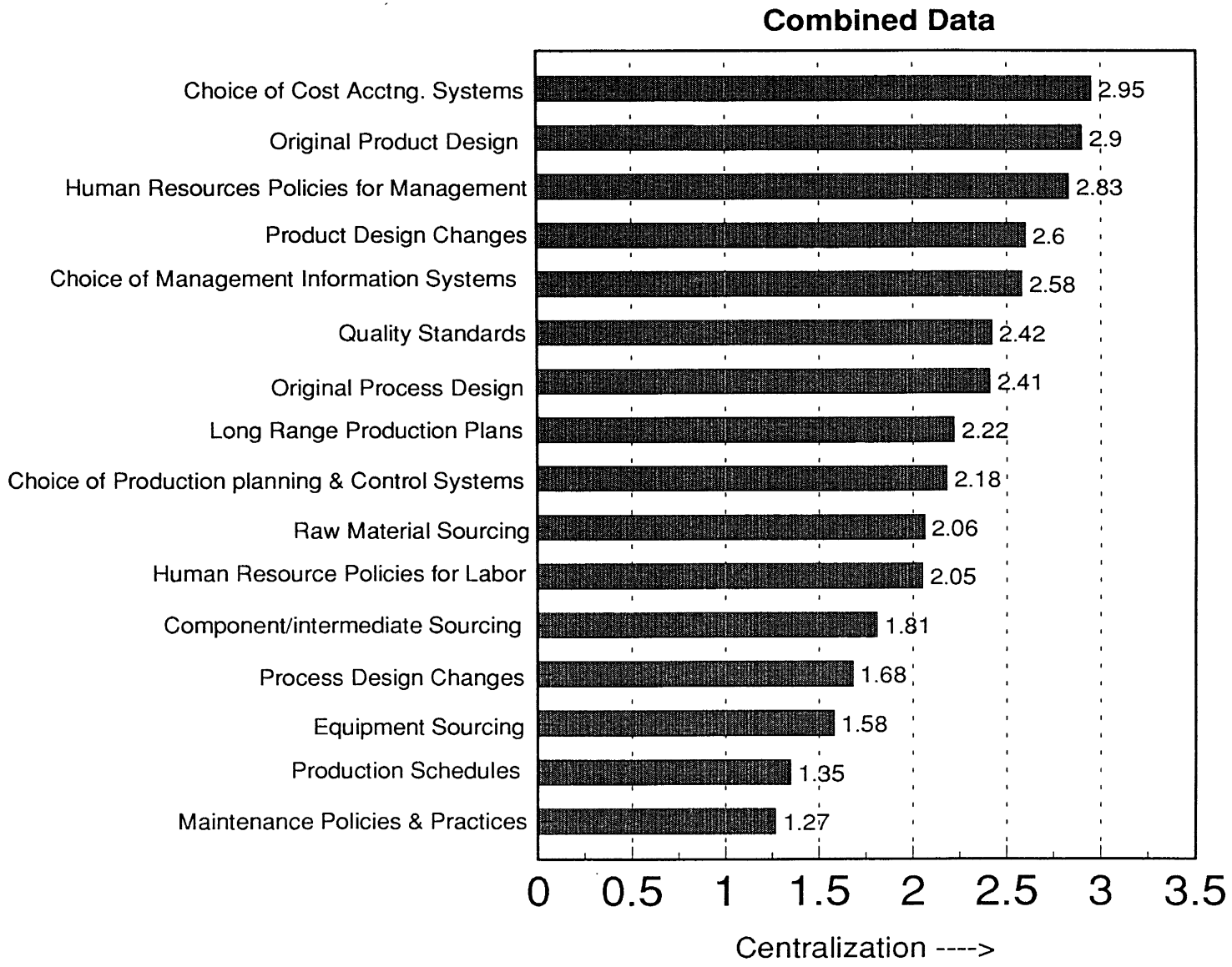
Responses 1, 2, 4 & 5 relate to the centralization of the decision making in the organization for a task. For example, if raw material sourcing was centralized the response is likely to be 1 or 2. Based on this hypothesis, a Degree of Centralization score was calculated for each task. The score is calculated by assigning points to the responses as follows

Worldwide headquarters = 4
Regional HQ = 3
Your plant in Coordination with another plant = 2
Your plant = 1
(note that response 3 , another plant, is excluded from the calculation)

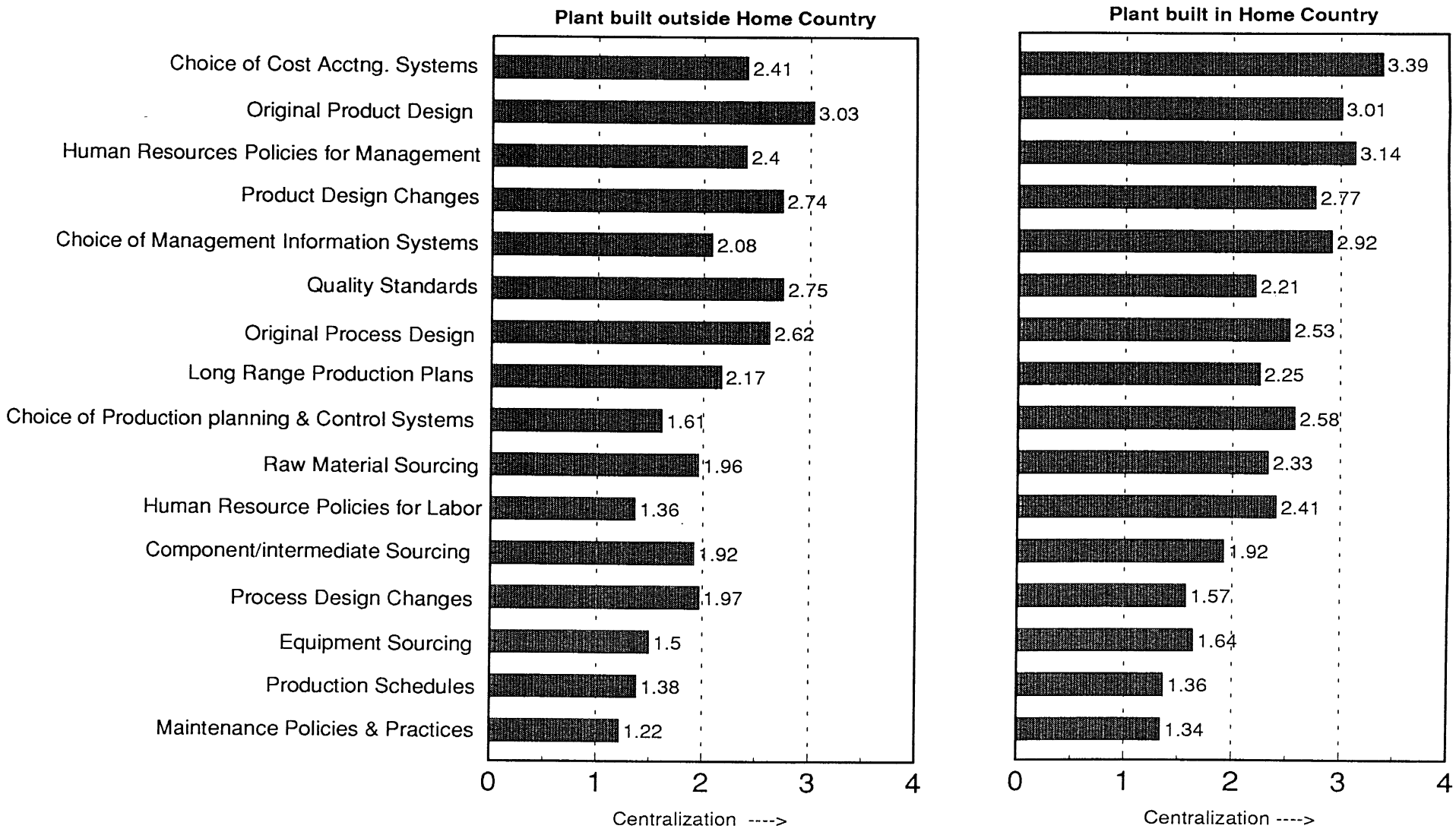
A higher score implies a higher degree of Centralization of the task. The scores for the data are depicted graphically on the next three pages. Cost Accounting systems, Product Designs and Human Resource Policies rank as the most centralized tasks. Not surprisingly, for these systems and Production Planning, headquarters had a significantly higher control over plants located in the home country than those located outside. The surprising observation is that Quality Standards were much more centralized for plants outside the home country.

The centralization score for Cost Accounting systems, Raw Material Sourcing, Production Planning & Control systems and Component/Intermediate Sourcing are noticeably lower for Japanese plants when compared to US and European plants. Product Design and Product Design Changes seem to be more centralized in Japanese owned plants.

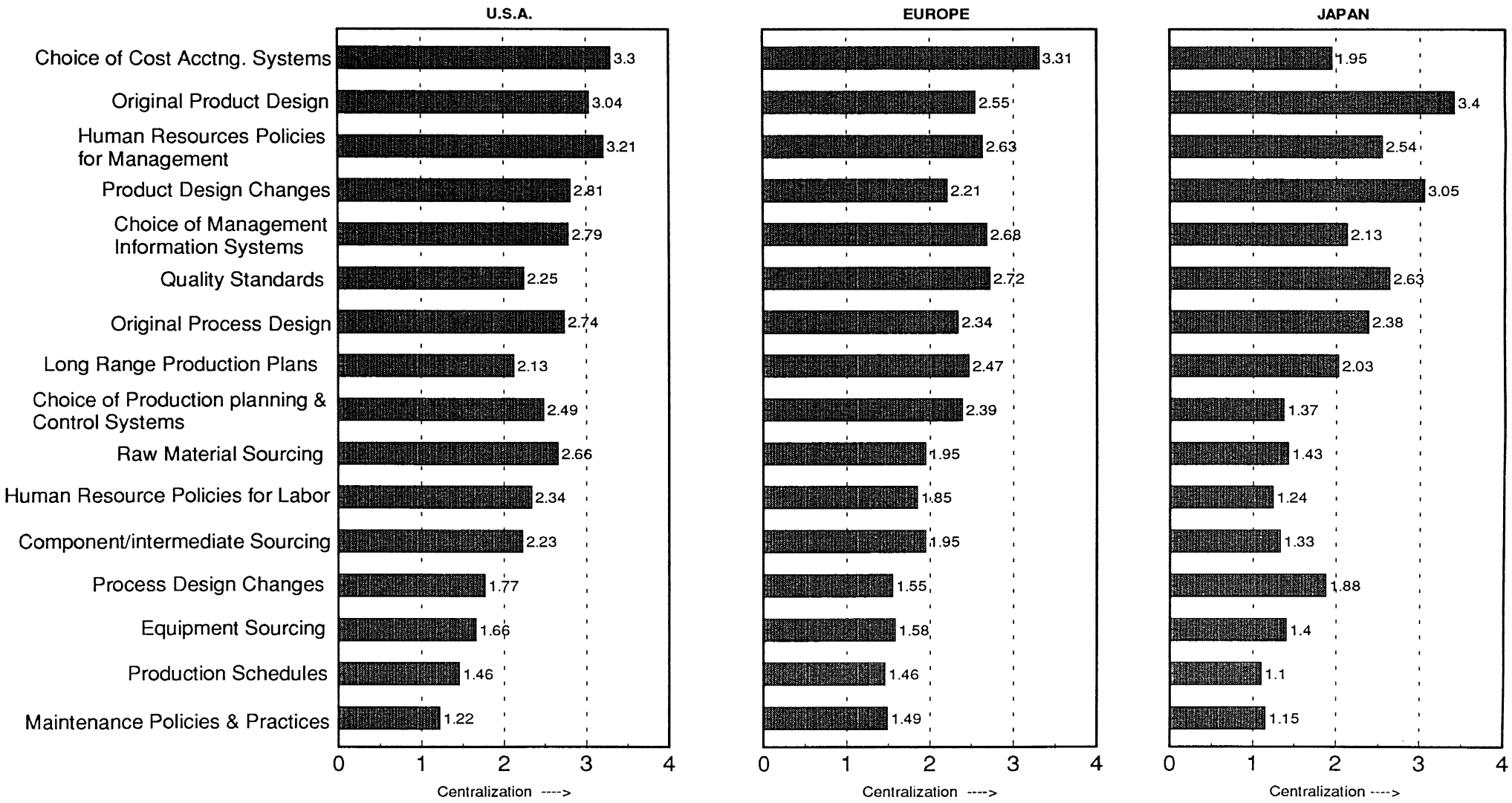
Degree of Centralization of Responsibilities



Degree of Centralization of Responsibilities - based on location of plant



Degree of Centralization of Responsibilities - by Region of Ownership



SECTION VI - PERFORMANCE

Q.1. How well does your plant perform compared to the world standard (best possible performance) with respect to each of the following dimensions?

The responses ranged from
1: hopeless to
5: On par with the best possible performance in the world.

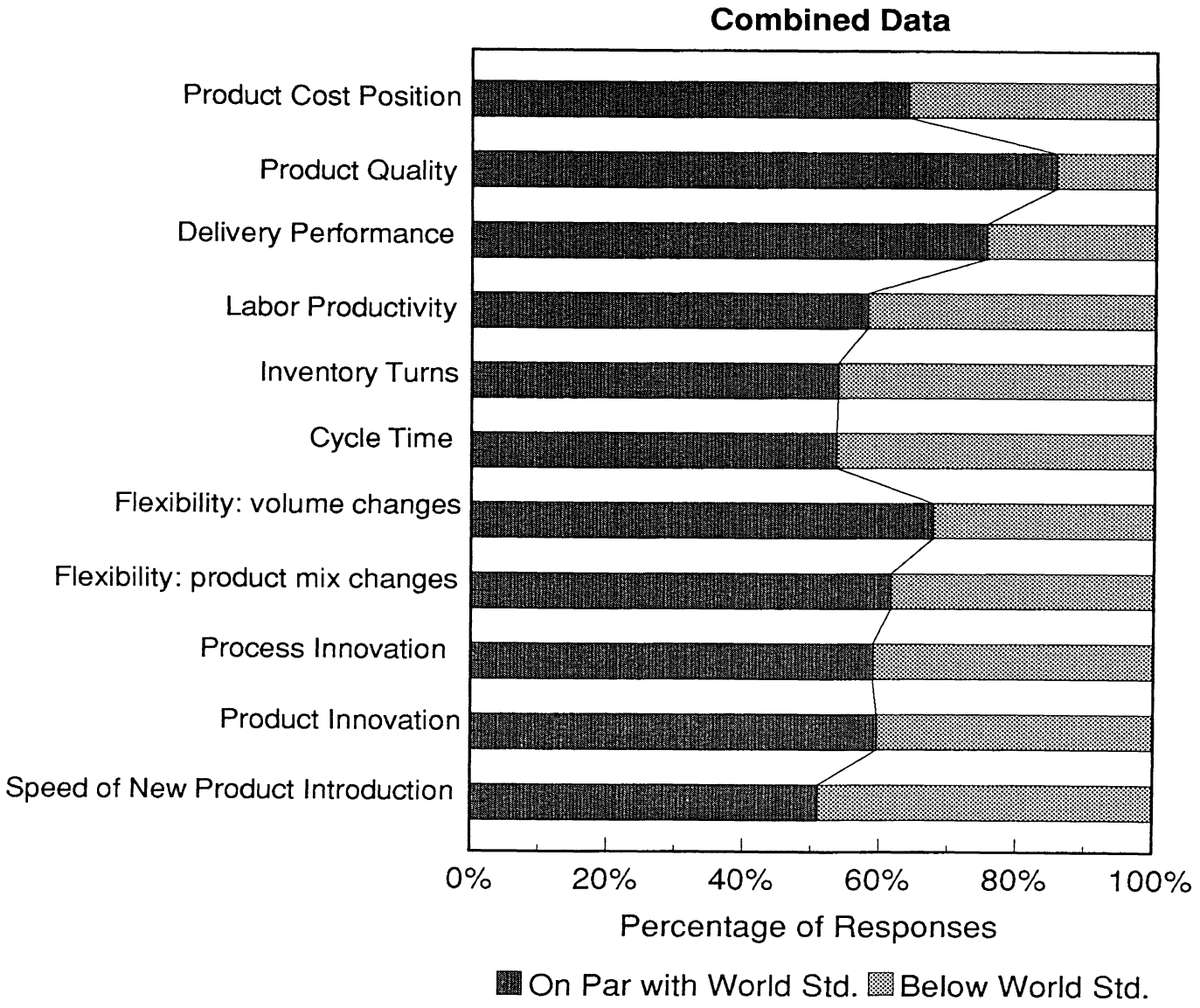
For the purpose of this analysis, responses that ranged from 1-3 were combined to arrive at a percentage of respondents who believed that their plant was below world standard on a dimension. Similarly, 4 & 5 were combined to calculate the percentage who believed that they were at least on par with the world standard on a dimension.

The grouped responses are depicted graphically in the next three pages. The aggregate data indicates that more than 80% of the respondents in our sample believed that their Product Quality and Delivery Performance were on par with world standard.

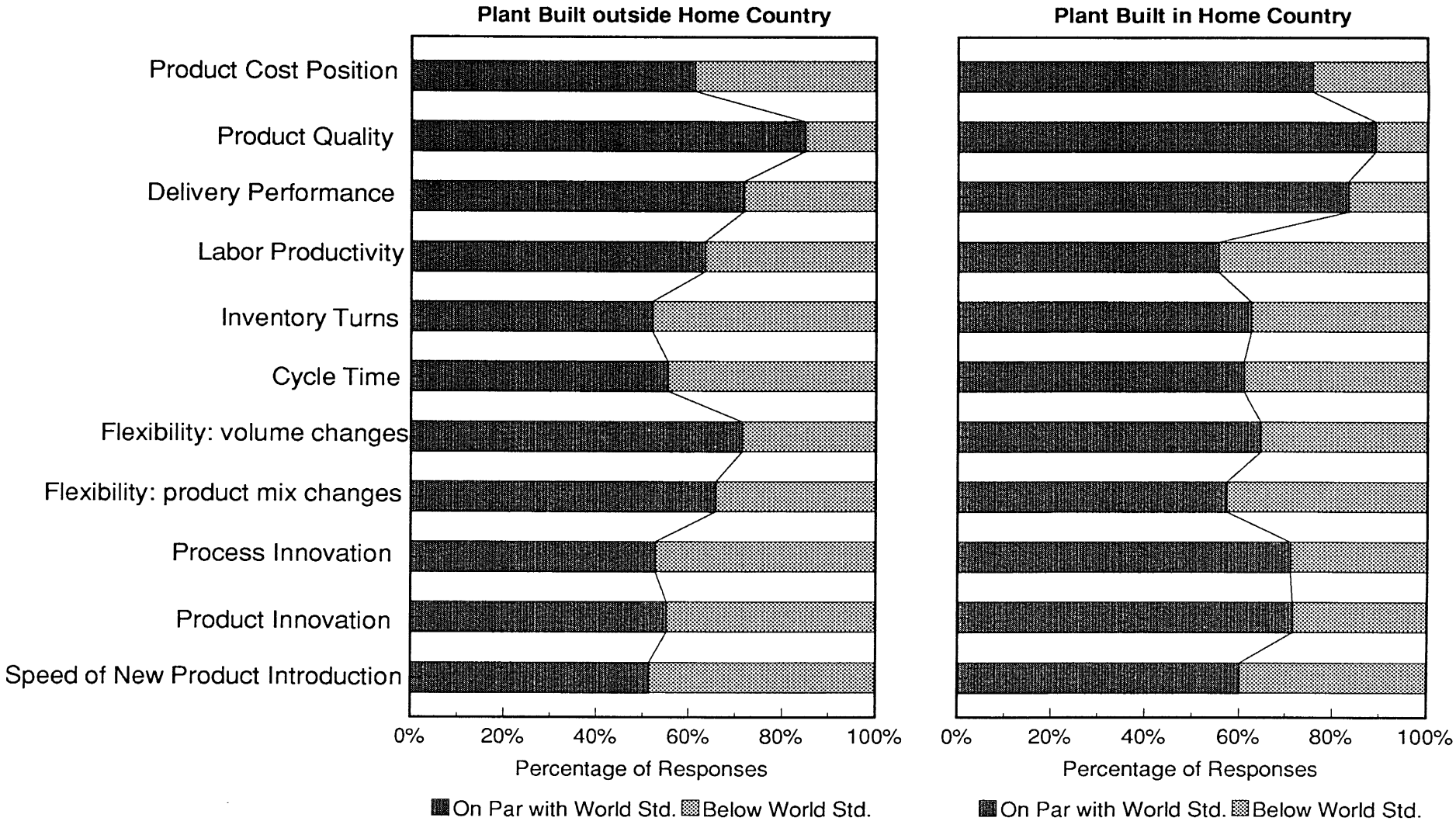
For every dimension, except Flexibility and Productivity, plants built in the home country received more 'on par with world standard' responses than plants built outside the home country.

Japanese owned plants had higher percentages of 'on par' responses than the US and European owned plants on every dimension. This is more noticeable on the dimensions Labor Productivity, Inventory Turns & Flexibility.

Performance Compared to World Standard



Performance Compared to World Standard



Performance Compared to World Standard - by Region of Ownership