Certification Study

Structural and Dynamic Analysis for the Optimization of Project and Human Resource Management in a Growing Construction Company

Tsirimpi Aikaterini

October 2025

Contents

1 Introduction

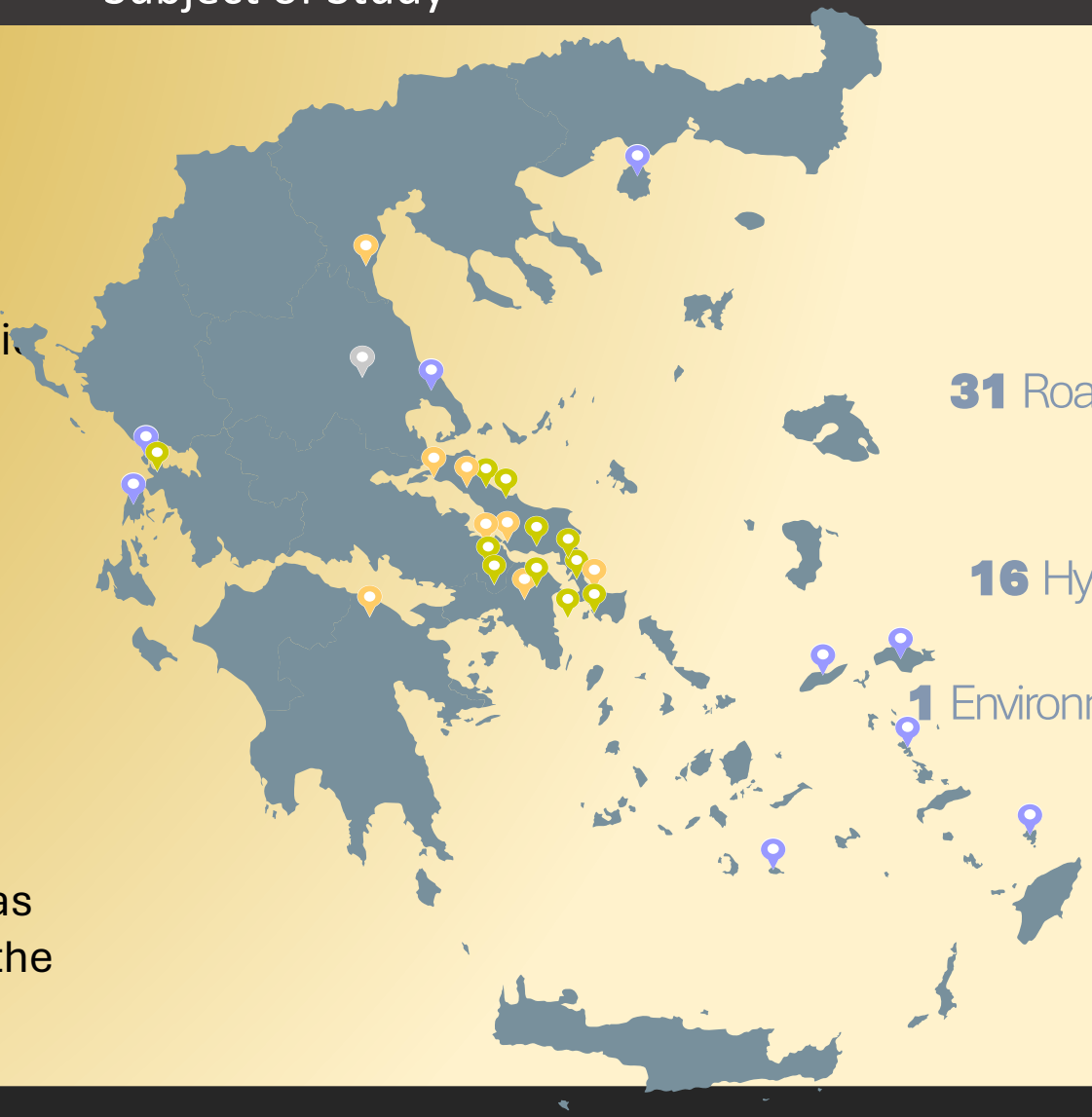
Subject of Study

- The examined Construction Company was founded in 1992 and is based in Greece.

- It operates in both the private and public sector, undertaking projects such as:

  - Port Works
  - Hydraulic Works
  - Road Construction Projects
  - Industrial Projects
  - Building Projects
  - Environmental Projects

- Its turnover exceeds €30 million and has been increasing by 60% annually over the past three years.



7 Port Projects

31 Road Construction Projects

16 Hydraulic Projects

1 Environmental Projects

Subject of Study

- **Main Challenges** due to Rapid Growth:

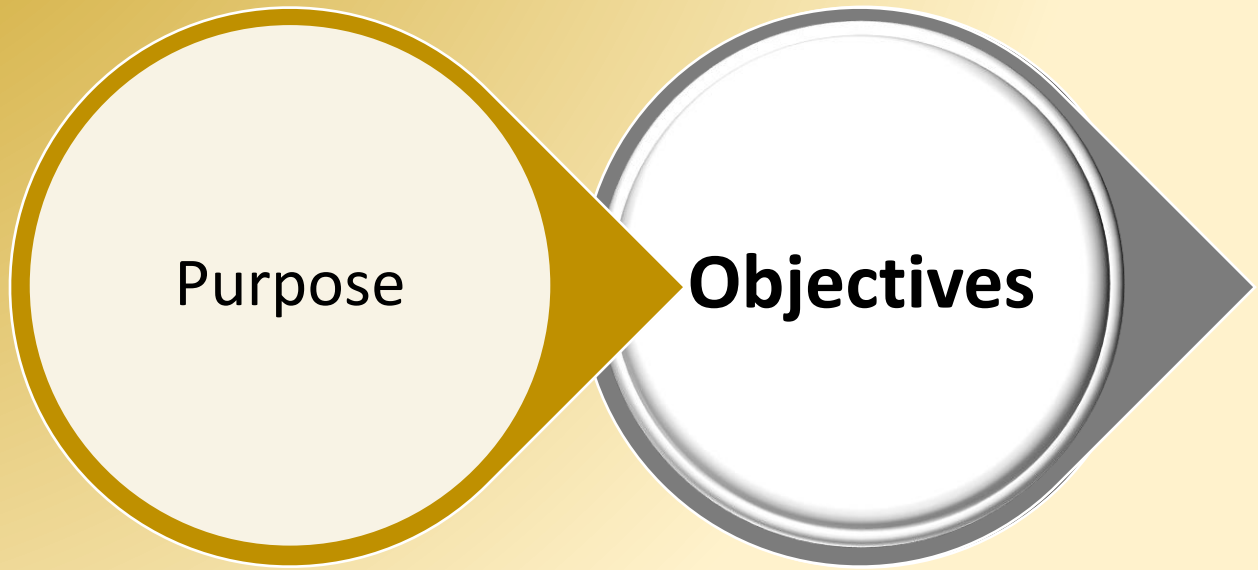
1. Rapid increase in the acquisition rate of high-specification projects
2. Need for additional personnel at both headquarters and construction sites
3. Continuous monitoring of productivity, performance, and pressure pressure
4. Strict contractual deadlines for project completion

- To examine and understand the contrasts and challenges faced by the Company

- To investigate the organizational structure and dynamics of the Company in relation to its available resources

Purpose / Objectives / Benefits of Study

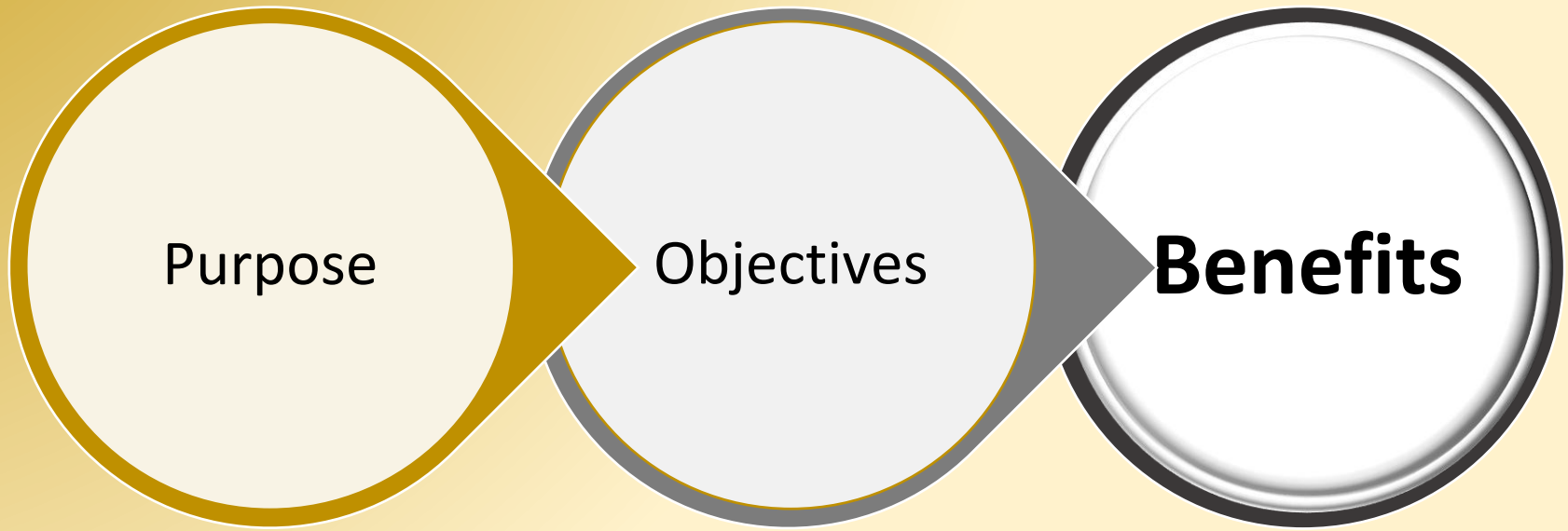
- To identify weaknesses, critical points, and interactions within the Organization



- To discover solutions through analysis and simulation of the organizational structure and operational performance of the Organization

Purpose / Objectives / Benefits of Study

- ✓ Developing of decision-making tools for structural adjustment and improved corporate operations



- ✓ Strengthening of strategic forecasting and adaptability under varying conditions

2 Systems Science

Overview of Systems Science

➢ **Systems thinking**

is a powerful contemporary tool for identifying and understanding the interactions among the components of a system and for **solving complex problems**.

➢ **Systems thinking**

enables the analyst to understand the whole system, interpret its behavior, and focus on the role of functions within the system, ceasing to operate with mechanistic thinking.

Systemic Methodologies

1. Data Collection

2. Information: Data processing

Goal : to understand the entirety of an examined System, its individual components, and its relationships that connect them

3. Knowledge: Understanding of know-how

4. Wisdom: Problem existence

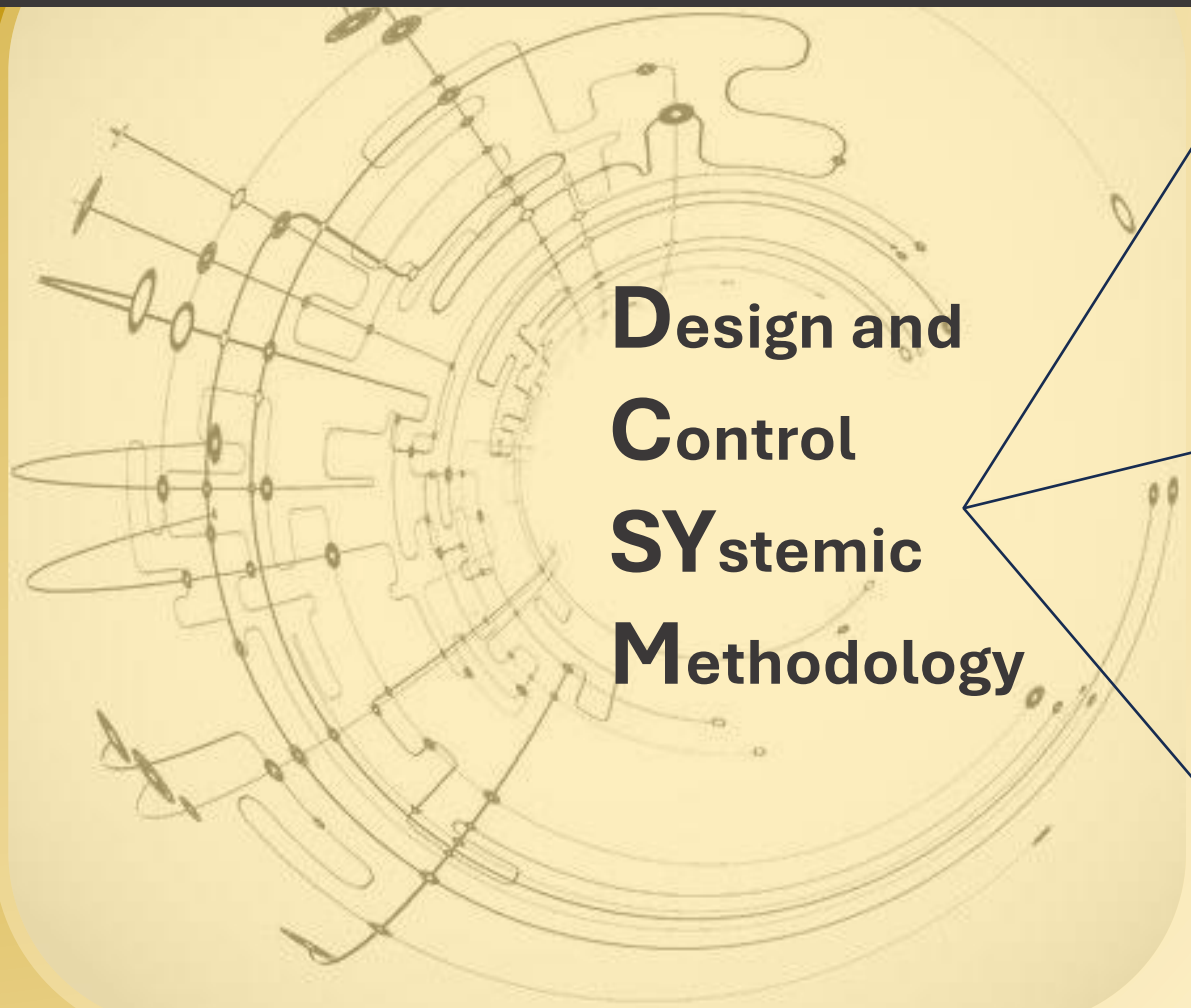
Systemic Methodologies

- **Design and Control Systemic Methodology (DCSYM)**

Multi-methodological Approach

- **System Dynamics Methodology (VENSIM)**

3 DCSYM



Design and Control SYstemic Methodology

- Focuses on representing the organizational structure of the examined Organization.
- Supports the depiction and evaluation of communication flows among subsystems
- Identifies bottlenecks, and detects communication gaps through control mechanisms

Existing Situation of the Study's Problem

1. Limited availability of qualified personnel in the labor market

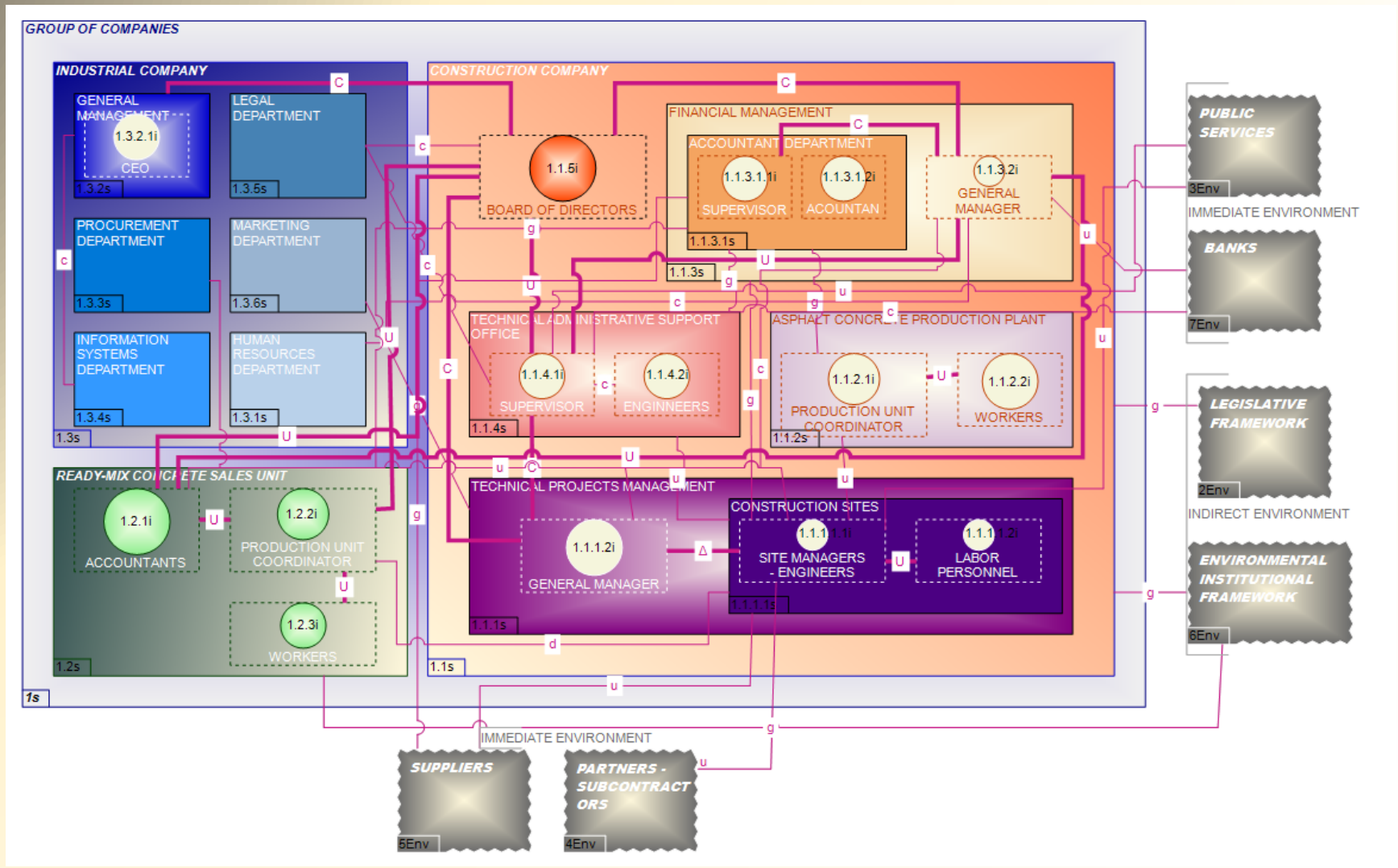
2. Understaffing of departments and workload burden on existing staff

3. Limited number of qualified employers in administrative departments, assumption of general duties

4. Insufficient control and information distortion

5. "Borrowed" services from the parent company, adding extra operational burden of work

Design of the Existing Condition with the DCSYM Case Tool Software



Intervention Improvements

i. Redesign of Company structures through the development of new management positions

ii. Division of the Organization's existing departments

iii. Reassignment of roles and responsibilities

iv. Reduction of excessive working hours

i. Hiring of new qualified personnel with the ability to be trained immediately for smooth integration into their new duties.

ii. Hiring and training of unqualified personnel for a long-term integration plan into suitable positions

i. The new System's structure creates smooth communication channels

ii. Difficult communication patterns and pressures between existing departments are alleviated

i. Systematic controls are effectively supported

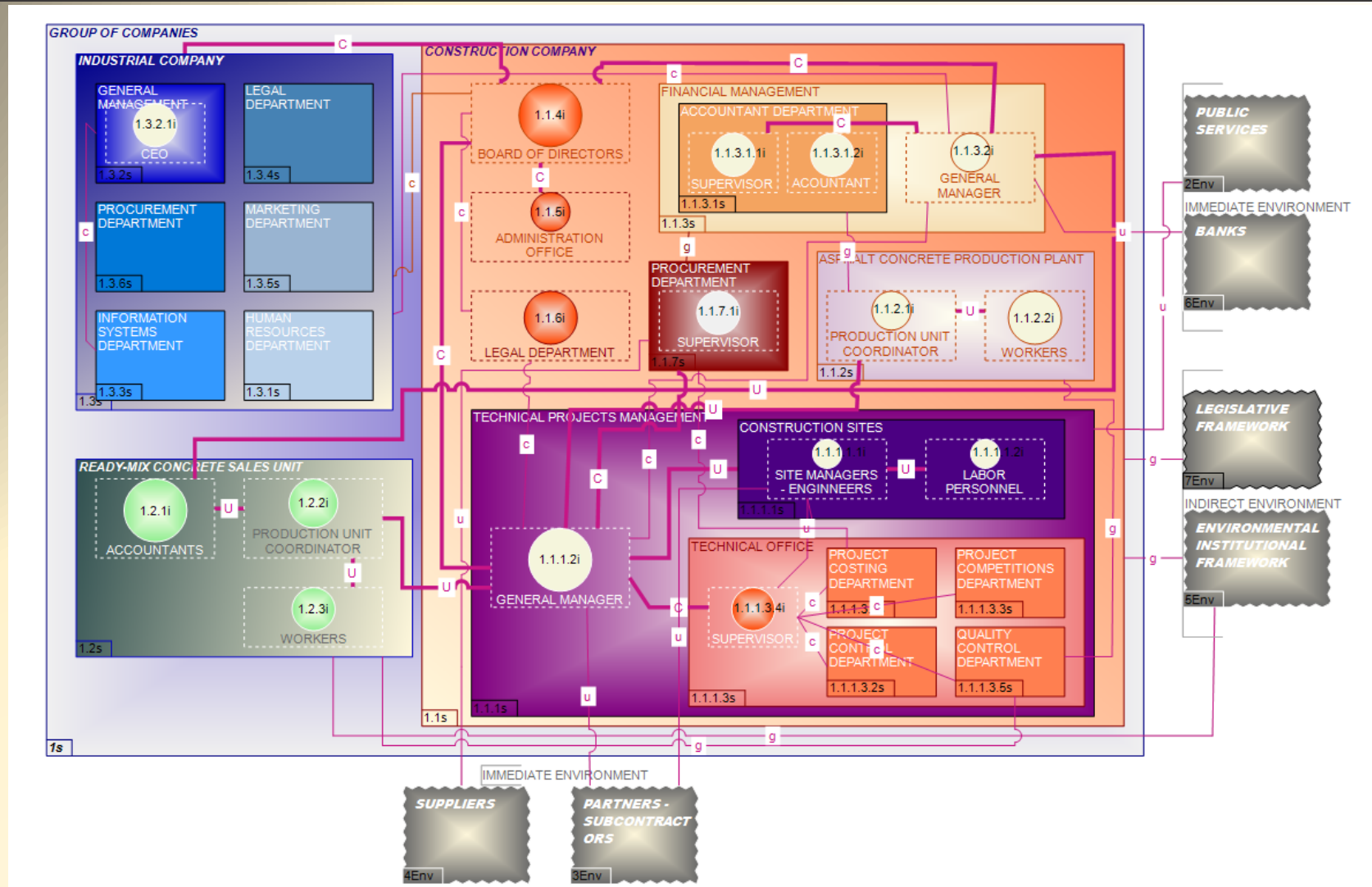
ii. Managerial positions play a substantial role by gathering the appropriate information

i. Elimination of work relationships with the parent Company

ii. Immediate solutions to the Company's critical needs

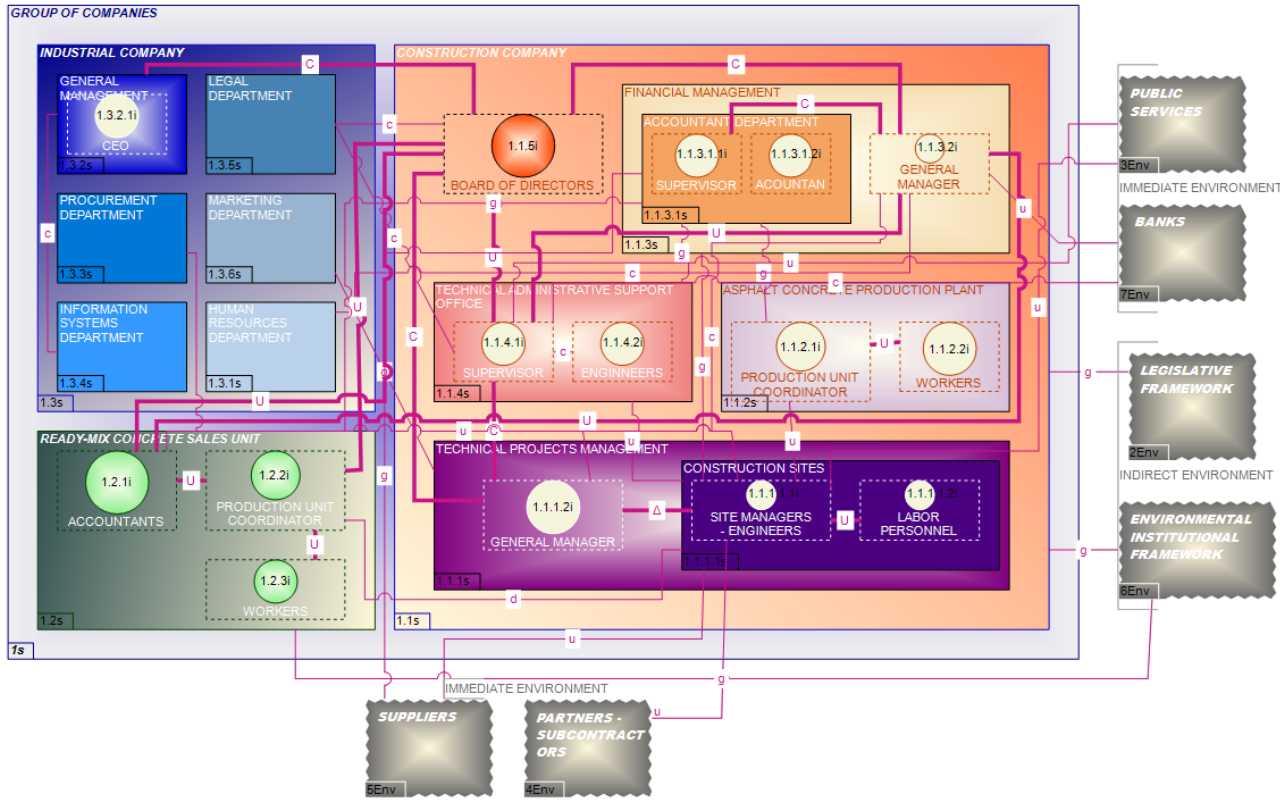
iii. Smooth operation of the Company without time delays

Design of Intervention Improvements with the DCSYM Case Tool Software

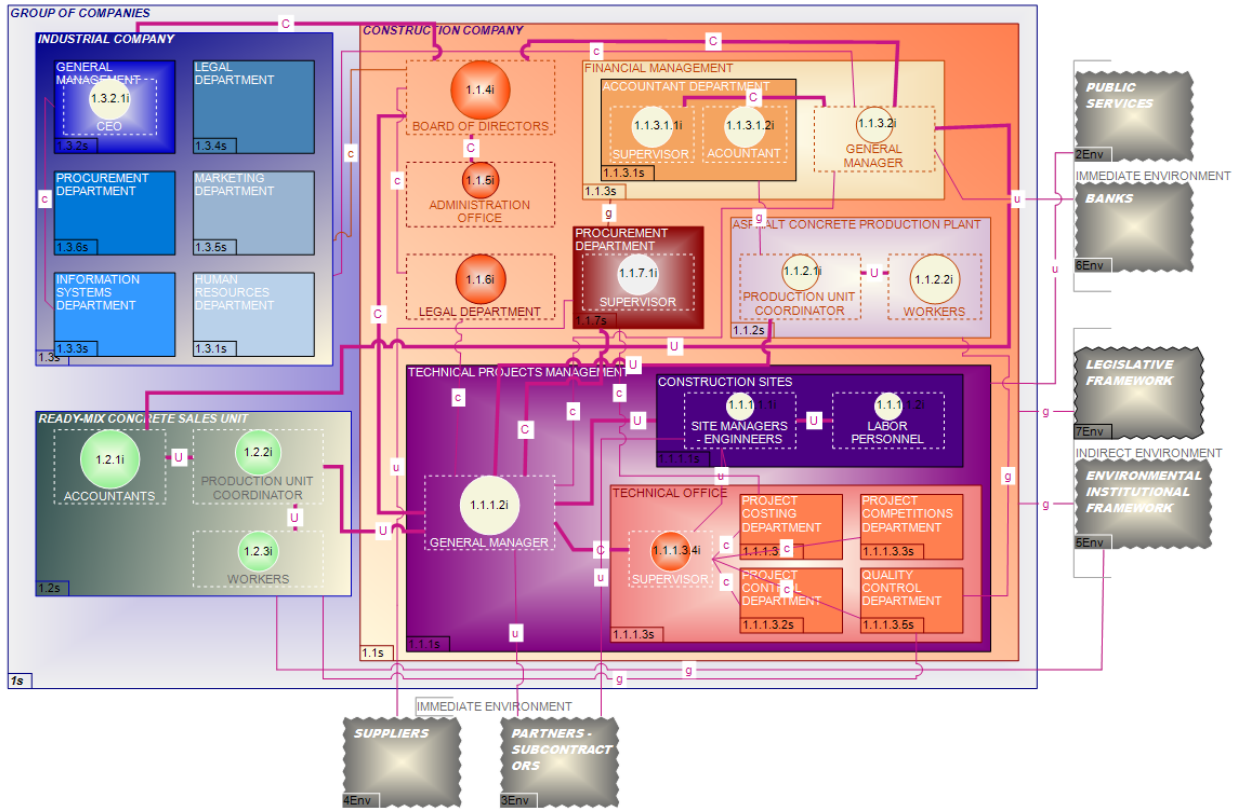


Comparison Between Existing and Desired Condition

Existing Condition



Desired Condition



Key Comparison Highlights

- **Redesign** of the organizational **structures**
- **Improved communication** channels
- **Termination of dependency relations** with the parent Company
- Achievement of systematic and reliable **control processes**
- **Reduction of** internal and external **pressures**

Overall Benefits

- ✓ **User-friendly software** with fast familiarization
- ✓ **Visual representation of complex Systems** and communication networks
- ✓ Clear identification of systemic problems and **implementation of targeted interventions**
- ✓ **Clear comparison** between the existing and desired condition

4

VENSIM

System Dynamic

1. **Representation** and simulation **of organizational complexity**

2. **Identification of behaviors** that contribute to systemic issues

3. **Identification of cause-and-effect relationships** that negatively affect the behavior of the overall system

VENSIM - System Dynamics Modelling

1. **Stock & Flow Diagram Design**
2. **Definition of Model Equations**
3. **Run Simulation**
4. **Export Charts**

1. Stock & Flow Diagram Design

❑ **Stocks**:

- Elements where information is accumulated from System variables
- They represent quantities that change cumulatively over time

❑ **Flows**:

- They represent processes that cause System transformations from one state to another
- They feed the Stocks

❑ **Constants & Auxiliaries**:

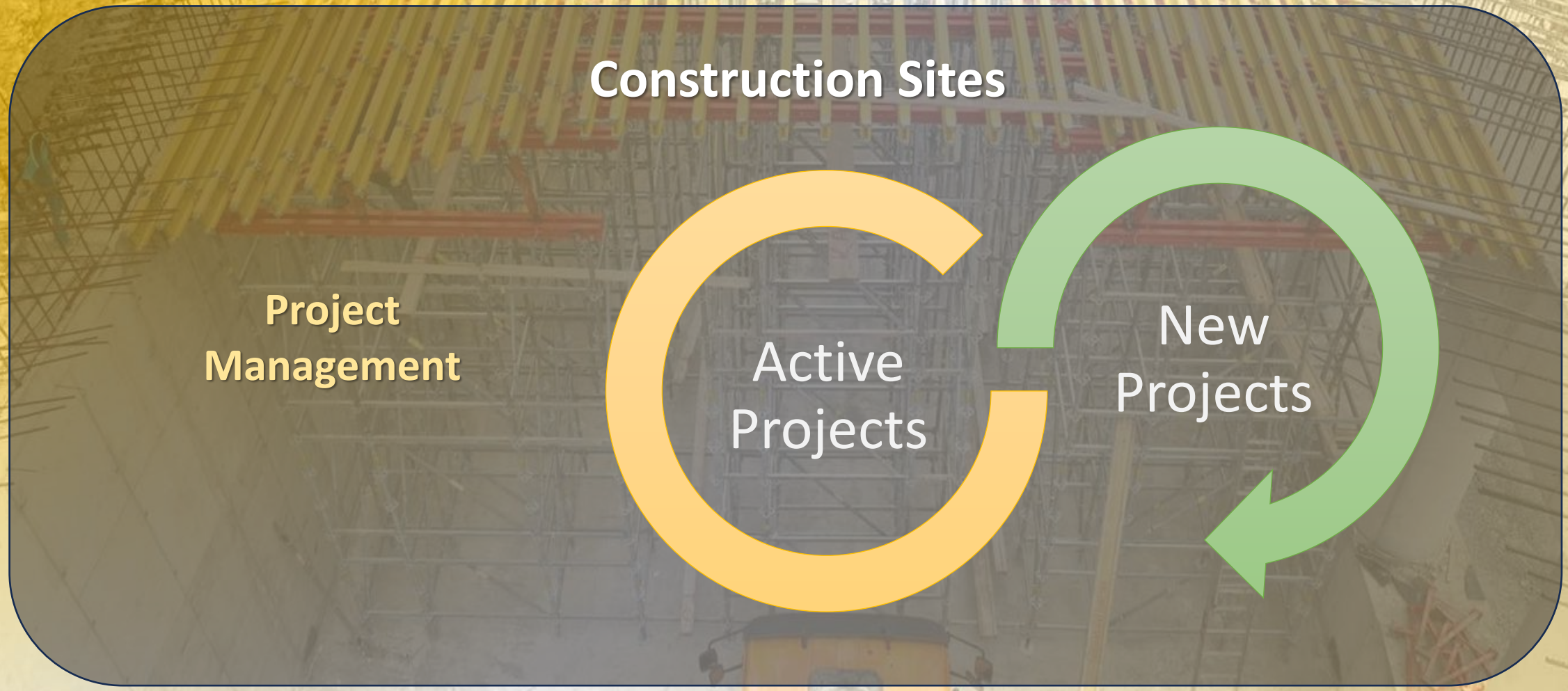
- Elements that are expressed through quantities with variable, constant values, or computational functions
- They feed both the Stocks and the Flows

Construction Sites

Human Resource Management

Hierarchy of typical construction site

Model Object's Description



➢ The examined Vensim Model simulates:

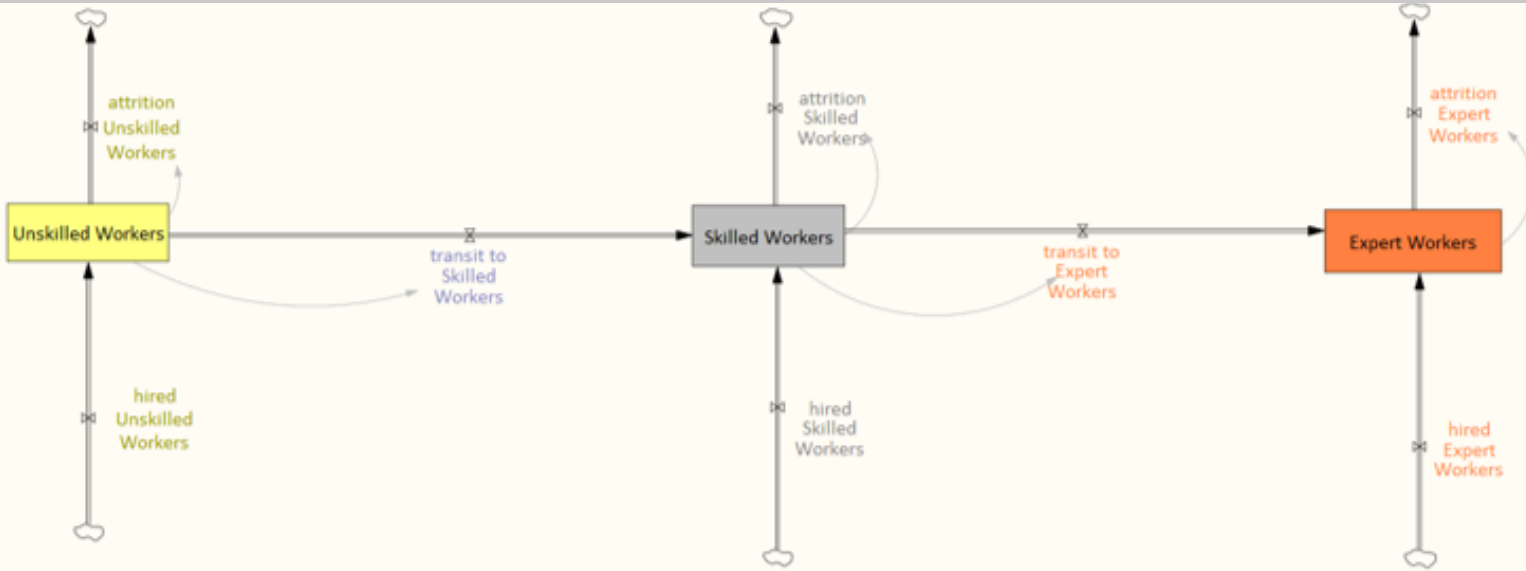
1. Hiring, attrition, and promotion flows
2. Execution and acquisition rate of technical projects
3. Production capability
4. System pressure

➢ Under three different conditions:

1. Crisis period
2. Recovery period
3. Growth period

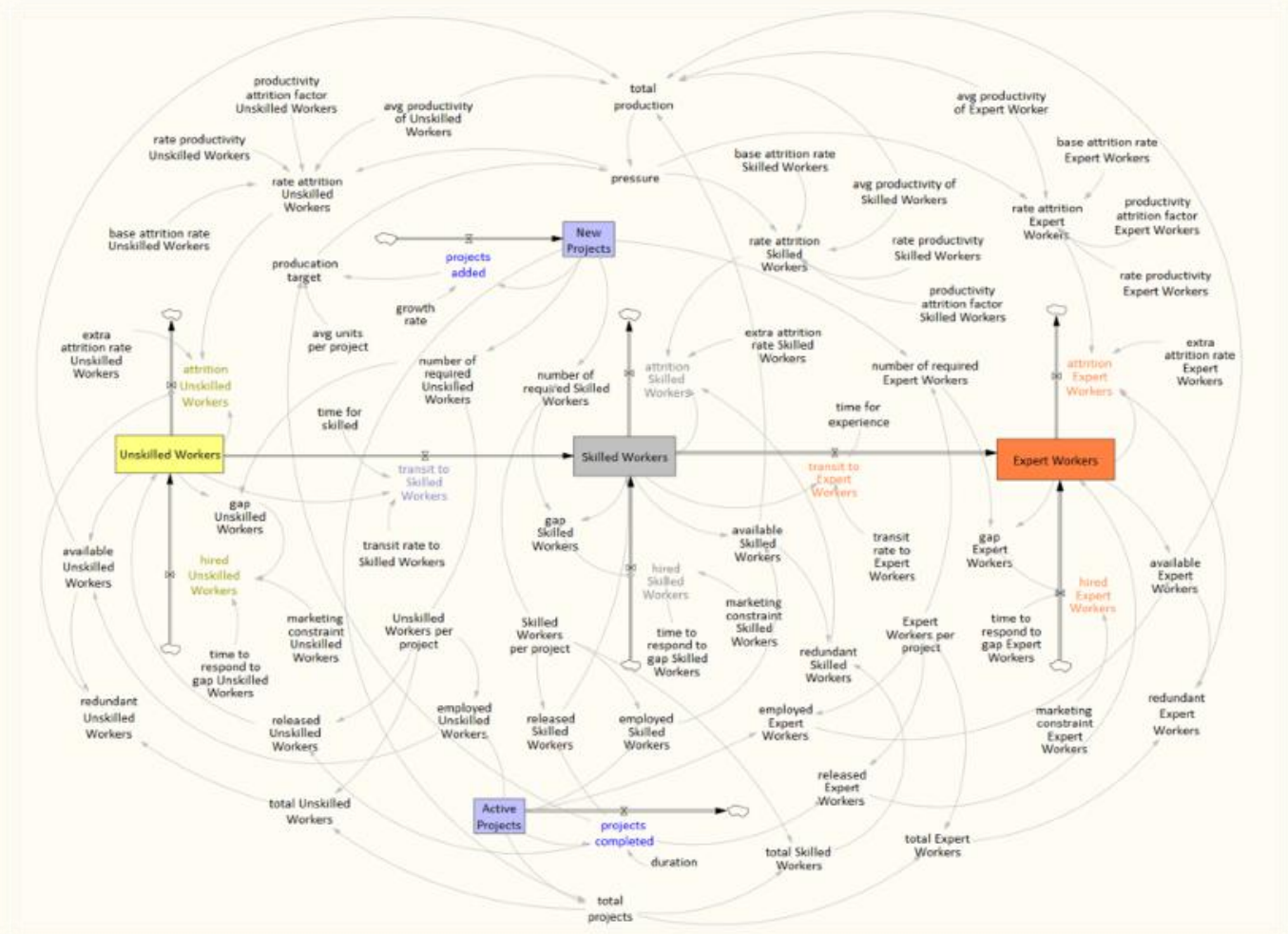
Identification of Stocks & Flows

Human Resources

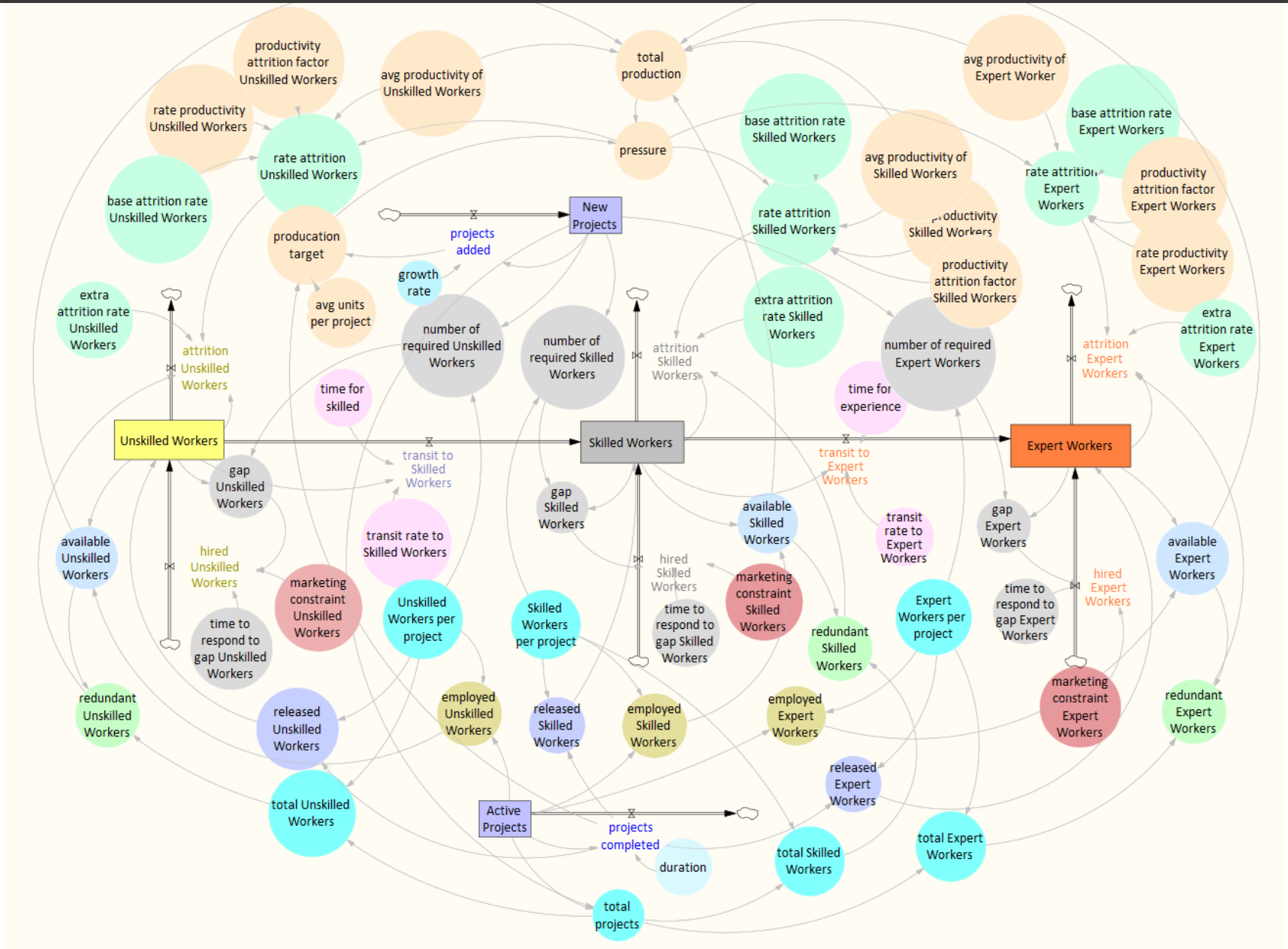


Technical Projects

The Vensim Model



Identification of Constants & Auxiliaries



Vensim Simulation Software

1. **Stock & Flow Diagram Design**
2. **Definition of Model Equations**
3. **Run Simulation**

INITIAL TIME = 1

FINAL TIME = 120

TIME STEP = 1

Units for Time = Month

Vensim Simulation Software

1. **Stock & Flow Diagram Design**
2. **Definition of Model Equations**
3. **Run Simulation**
4. **Export Charts**

Simulation of Model Execution

Parameters		Scenario 1
avg productivity	EXPERTS [0.1-2]	0.5
	SKILLED [0.1-2]	0.5
	UNSKILLED [0.1-2]	0.4
avg units per project	100 έως 1000	500
base attrition rate	EXPERTS [0.001-0.05]	0.001
	SKILLED [0.001-0.05]	0.001
	UNSKILLED [0.001-0.05]	0.001
duration	6-34	24
extra attrition rate	EXPERTS [0.01-0.5]	0.4
	SKILLED [0.01-0.5]	0.3
	UNSKILLED [0.01-0.5]	0.3
growth rate	-0.02 – 0.02	-0.015
marketing constraint	EXPERTS [0.1 -1]	0.2
	SKILLED [0.1 -1]	0.1
	UNSKILLED [0.1 -1]	0.5
productivity attrition factor	EXPERTS [0.1-1]	0.8
	SKILLED [0.1-1]	0.8
	UNSKILLED [0.1-1]	0.7
rate productivity	EXPERTS [-]	0.7
	SKILLED [-]	0.8
	UNSKILLED [-]	0.5
time for experience	24-48	36
time for skilled	12-24	15
time to respond to gap	EXPERTS [12-48]	48
	SKILLED [4-12]	12
	UNSKILLED [1-6]	6
Workers per project	EXPERTS [-]	1
	SKILLED [-]	3
	UNSKILLED [-]	2
transit rate	EXPERTS [0.01-1]	0.01
	SKILLED [0.01-1]	0.2

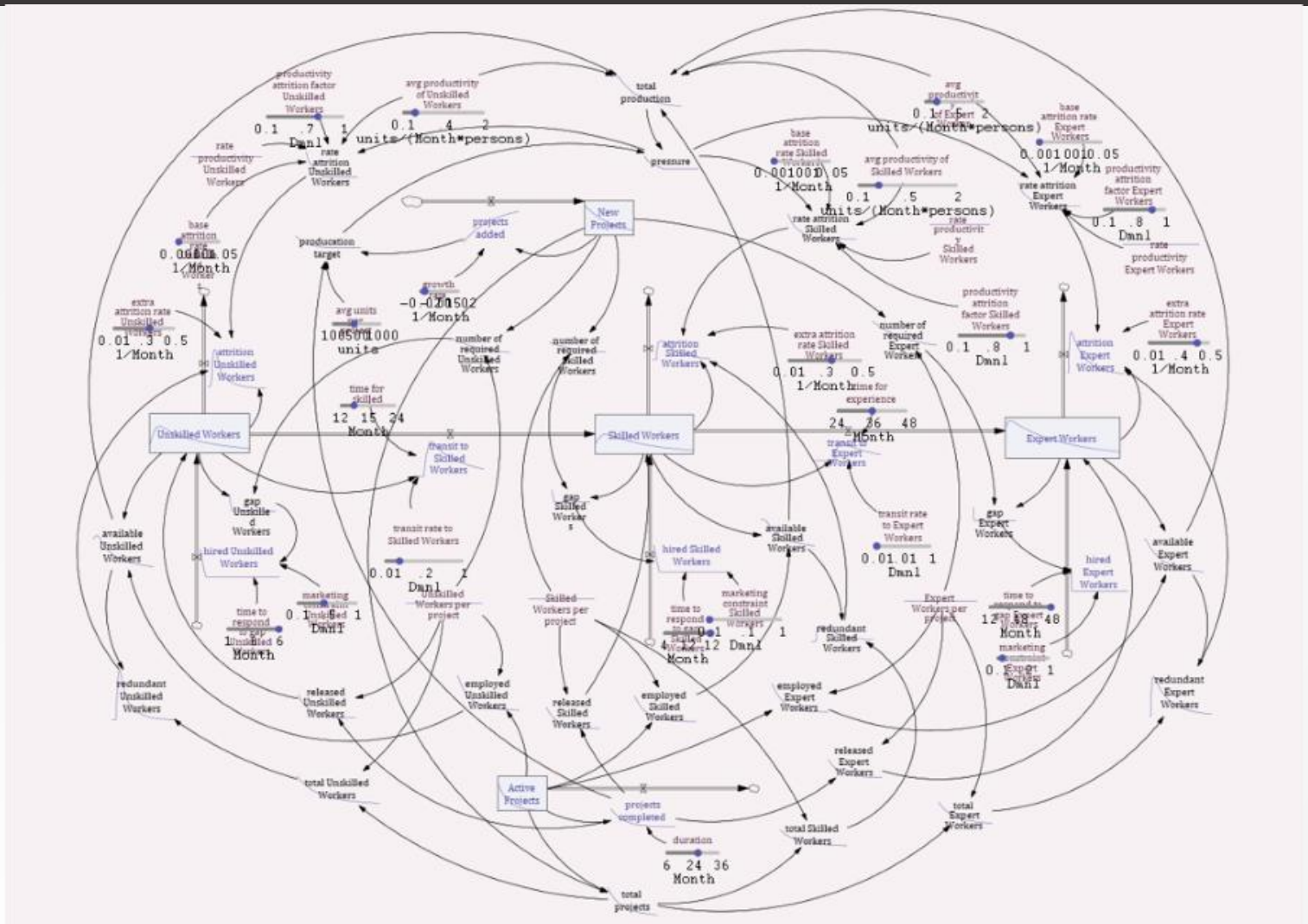
Scenario 1: Crisis Period

i. Reduced capability for **new project acquisition**

ii. Reduced **recruitment**

iii. High **attrition** rates

Simulation of Model Execution



Simulation of Model Execution

Paramenters		Scenario 2
avg productivity	EXPERTS [0.1-2]	1.8
	SKILLED [0.1-2]	1.8
	UNSKILLED [0.1-2]	1.5
avg units per project	100 έως 1000	300
base attrition rate	EXPERTS [0.001-0.05]	0.009
	SKILLED [0.001-0.05]	0.008
	UNSKILLED [0.001-0.05]	0.01
Duration	6-34	24
extra attrition rate	EXPERTS [0.01-0.5]	0.15
	SKILLED [0.01-0.5]	0.48
	UNSKILLED [0.01-0.5]	0.45
growth rate	-0.02 – 0.02	0.013
marketing constraint	EXPERTS [0.1 -1]	0.3
	SKILLED [0.1 -1]	0.3
	UNSKILLED [0.1 -1]	0.7
productivity attrition factor	EXPERTS [0.1-1]	0.2
	SKILLED [0.1-1]	0.7
	UNSKILLED [0.1-1]	0.8
rate productivity	EXPERTS [-]	0.7
	SKILLED [-]	0.8
	UNSKILLED [-]	0.5
time for experience	24-48	40
time for skilled	12-24	20
time to respond to gap	EXPERTS [12-48]	40
	SKILLED [4-12]	12
	UNSKILLED [1-6]	3
Workers per project	EXPERTS [-]	1
	SKILLED [-]	3
	UNSKILLED [-]	2
transit rate	EXPERTS [0.01-1]	0.05
	SKILLED [0.01-1]	0.35

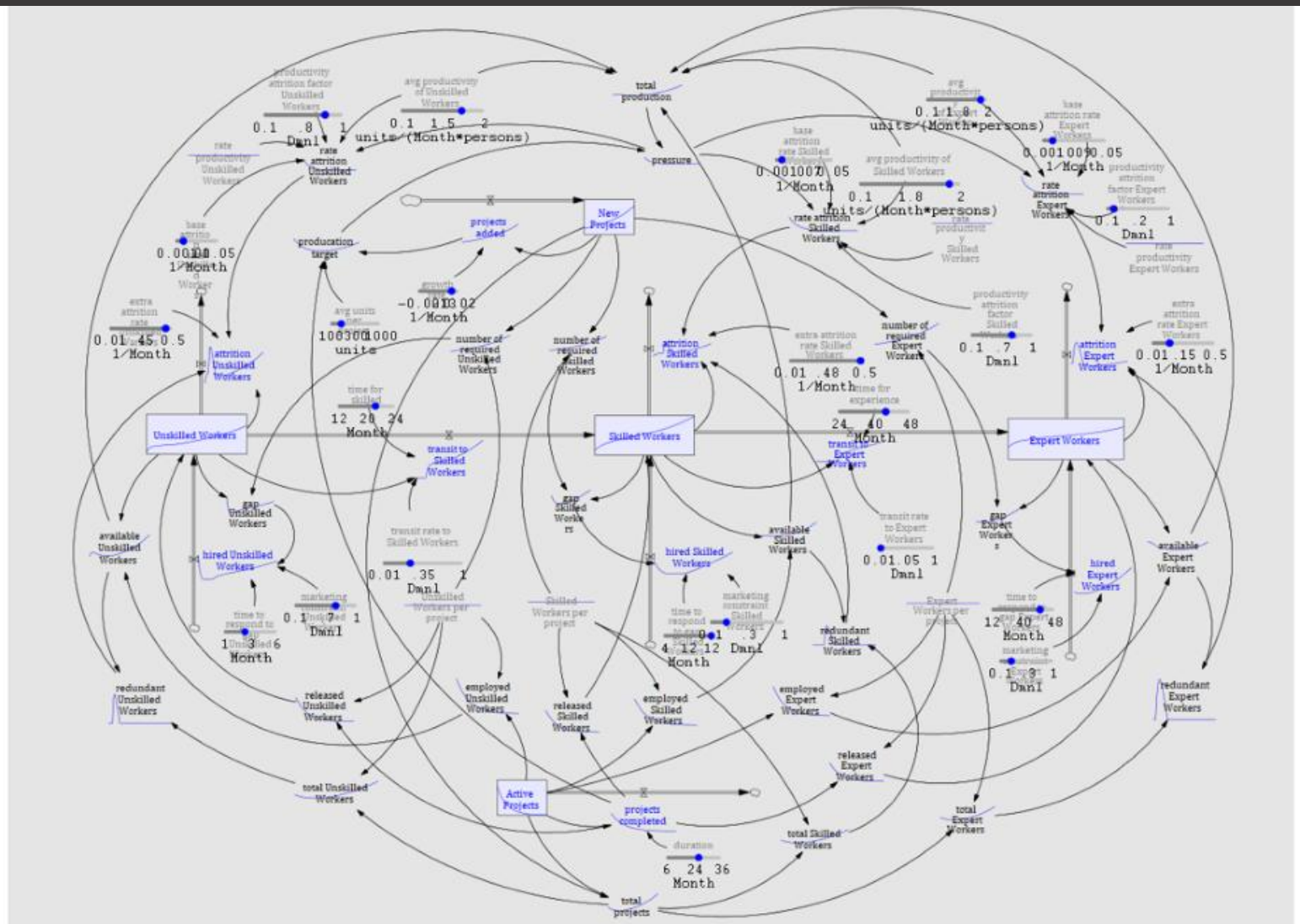
Scenario 2: Recovery/ Current period with constraints

i. Increased project **acquisition capability**

ii. Severe shortage of **skilled and expert workers** in the labor market

iii. Insufficient worker **training**

Simulation of Model Execution



•increased hiring

Simulation of Model Execution

Parameters		Scenario 3
avg productivity	EXPERTS [0.1-2]	1.2
	SKILLED [0.1-2]	1.5
	UNSKILLED [0.1-2]	0.9
avg units per project	100 έως 1000	800
base attrition rate	EXPERTS [0.001-0.05]	0.001
	SKILLED [0.001-0.05]	0.002
	UNSKILLED [0.001-0.05]	0.001
Duration	6-34	24
extra attrition rate	EXPERTS [0.01-0.5]	0.05
	SKILLED [0.01-0.5]	0.1
	UNSKILLED [0.01-0.5]	0.1
growth rate	-0.02 – 0.02	0.01
marketing constraint	EXPERTS [0.1 -1]	0.3
	SKILLED [0.1 -1]	0.3
	UNSKILLED [0.1 -1]	0.9
productivity attrition factor	EXPERTS [0.1-1]	0.1
	SKILLED [0.1-1]	0.1
	UNSKILLED [0.1-1]	0.2
rate productivity	EXPERTS [-]	0.7
	SKILLED [-]	0.8
	UNSKILLED [-]	0.5
time for experience	24-48	24
time for skilled	12-24	12
time to respond to gap	EXPERTS [12-48]	12
	SKILLED [4-12]	4
	UNSKILLED [1-6]	2
Workers per project	EXPERTS [-]	1
	SKILLED [-]	3
	UNSKILLED [-]	2
transit rate	EXPERTS [0.01-1]	0.08
	SKILLED [0.01-1]	0.5

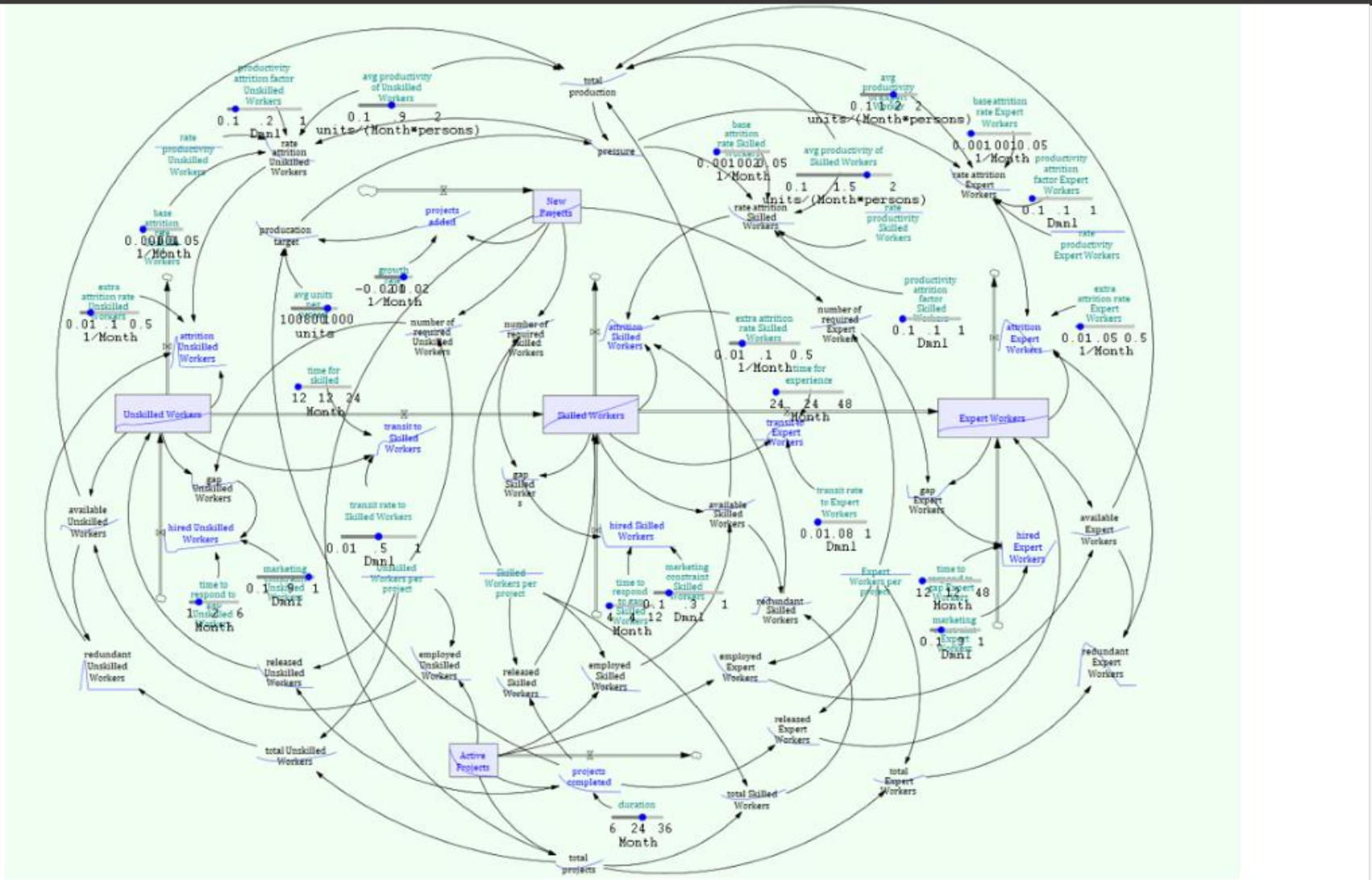
Scenario 3: Growth period

i. High capability for **new project acquisition**

ii. Increased **recruitment**

iii. Low **attrition** rates

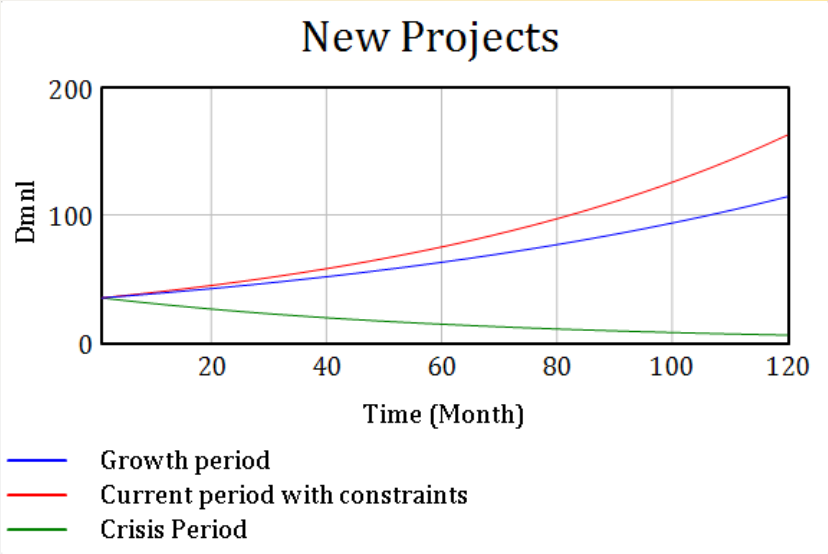
Simulation of Model Execution

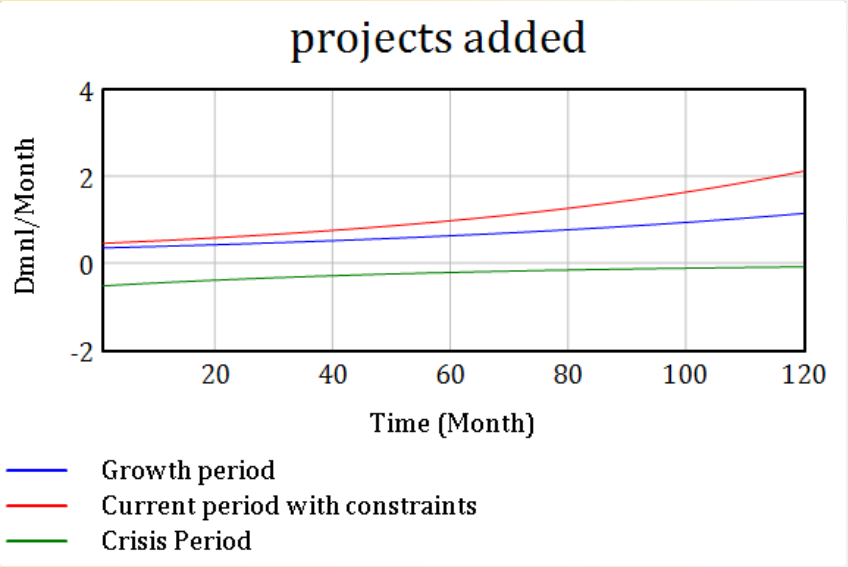


Key Trends in Graphs

➢ New Projects Trend

During the crisis period, a steady decline is observed in new project acquisition. In contrast, during the recovery (current period) and subsequent growth period, the inflow of new projects increases, creating the need to strengthen the Company's human resources.

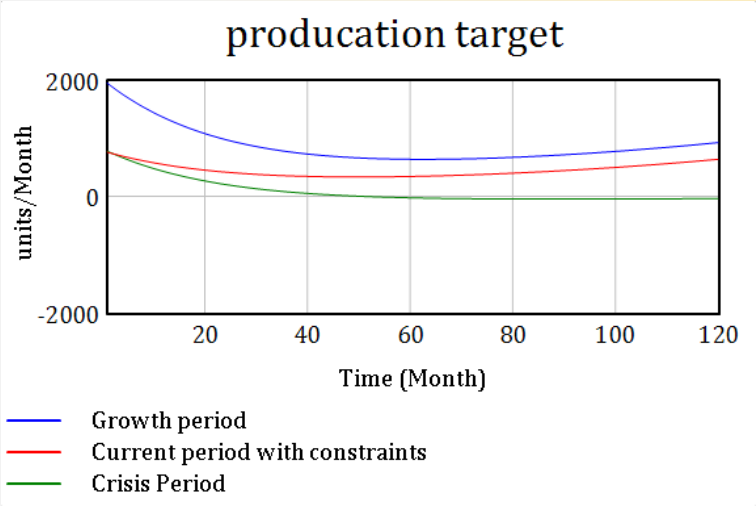


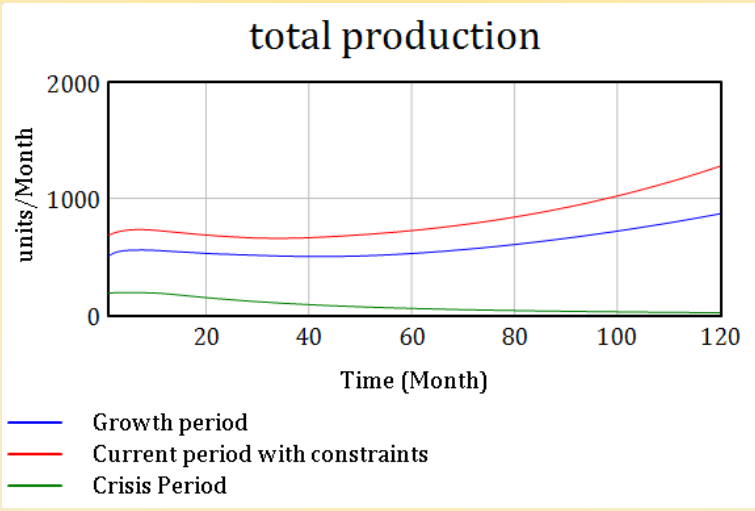


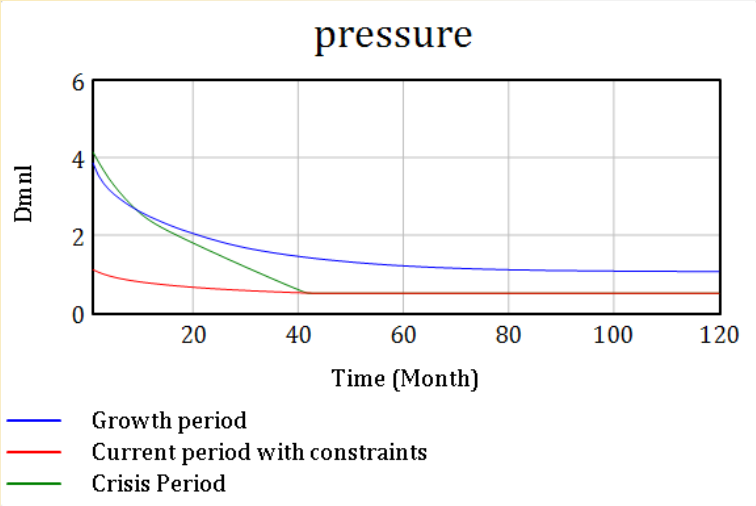
Key Trends in Graphs

➢ Production and Pressure Trend

The production and pressure trends across the different periods indicate the need to reduce the company's production targets, allowing the workforce to respond more effectively to prevailing conditions and meet the demands of each period in a more realistic manner. Accordingly, system pressure also decreases during these periods.



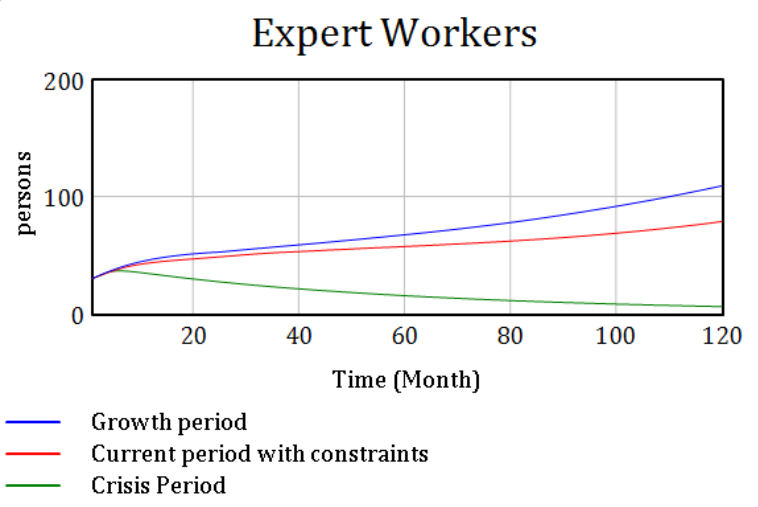


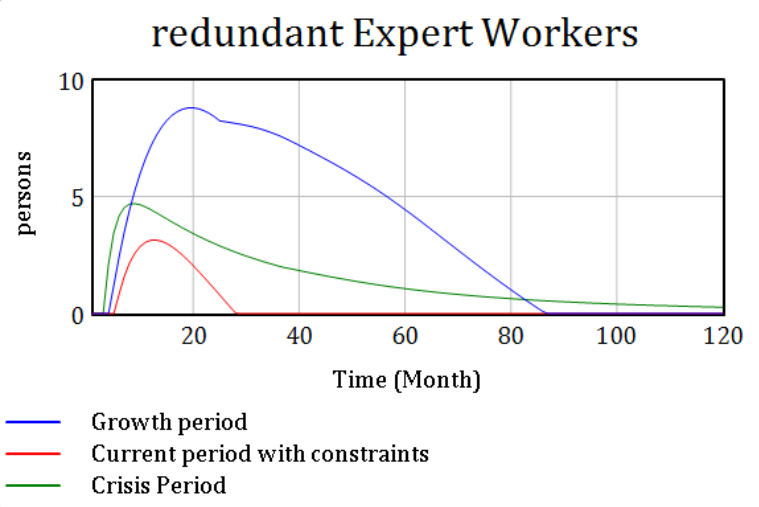


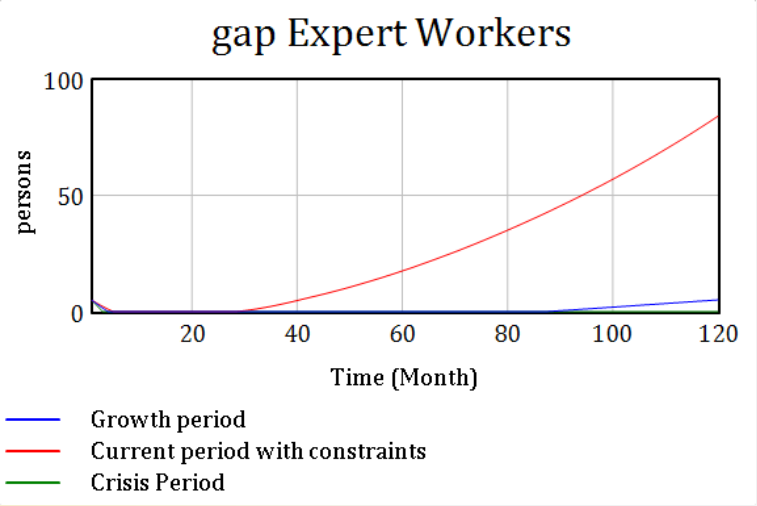
Key Trends in Graphs

➢ Conclusions for Expert Workers

Expert Workers exhibit significant attrition during crisis periods, as limited demand leads to a high number of surplus personnel. In contrast, during recovery and growth periods, demand increases; however, the simultaneous activation of promotions or new hires can temporarily create an oversupply. Critical gaps arise when the Expert tier is not reinforced in a timely manner—a phenomenon particularly evident in the current period due to the reduced lead time required for Skilled workers to be promoted and trained up to Expert level.



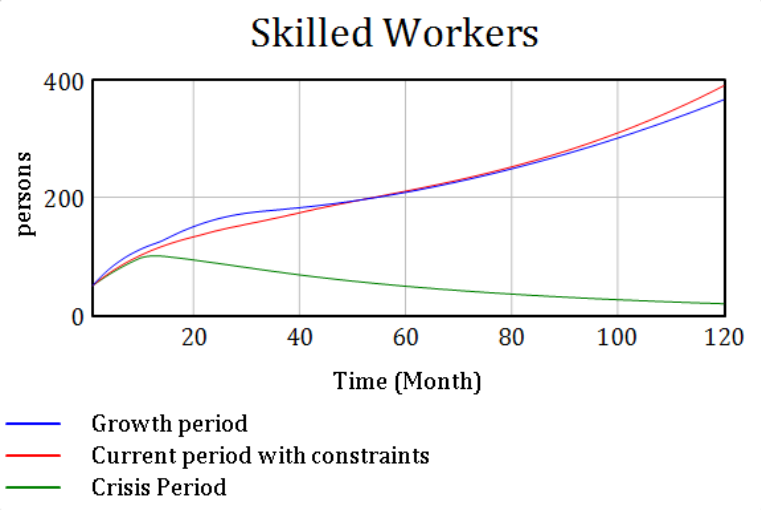


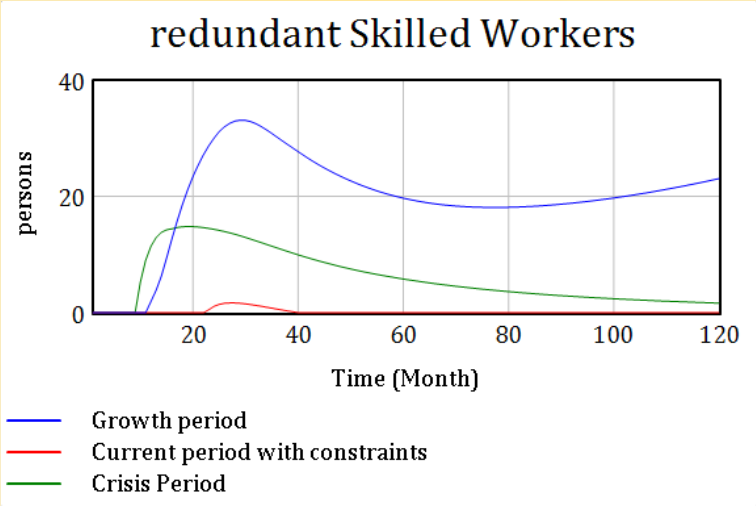


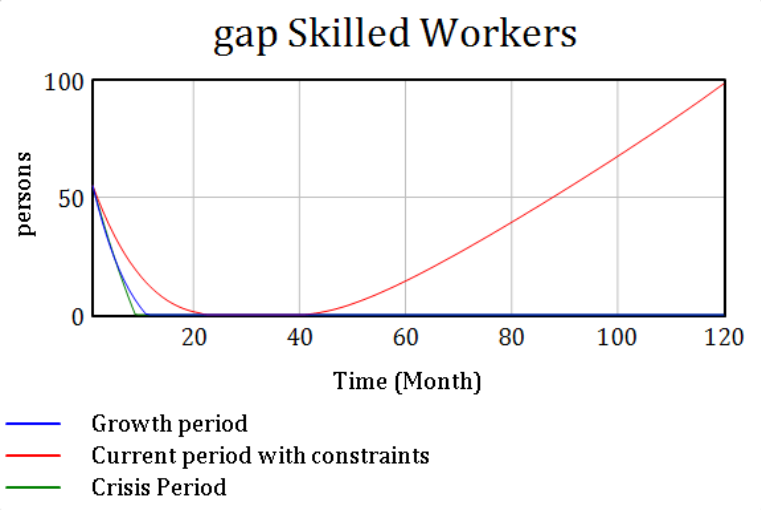
Key Trends in Graphs

➢ Conclusions for Skilled Workers

Similarly, the number of Skilled Workers decreases significantly during crisis periods, while demand rises sharply during recovery and growth periods. In the current context, delays in training further exacerbate the gap between the available Skilled Workers and the levels required by the system.



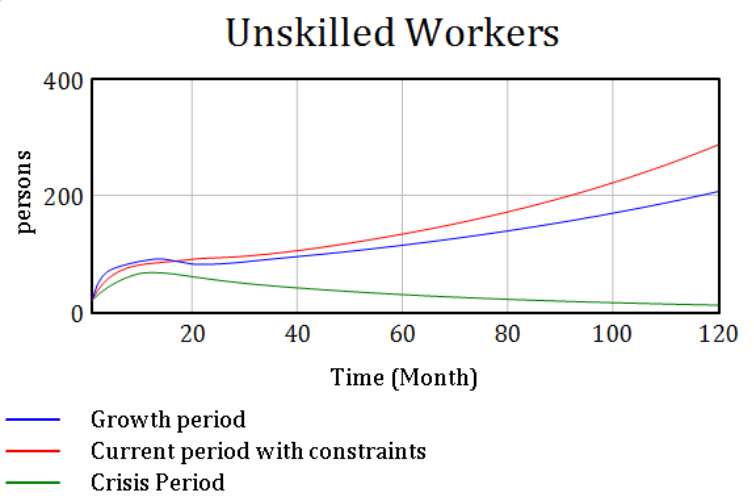


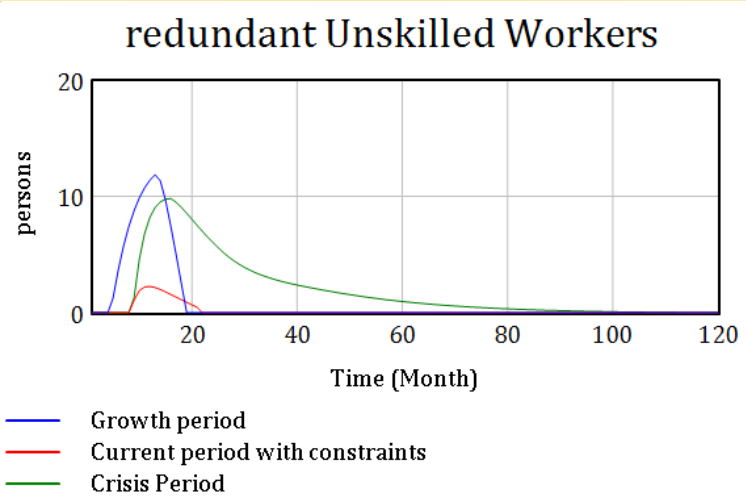


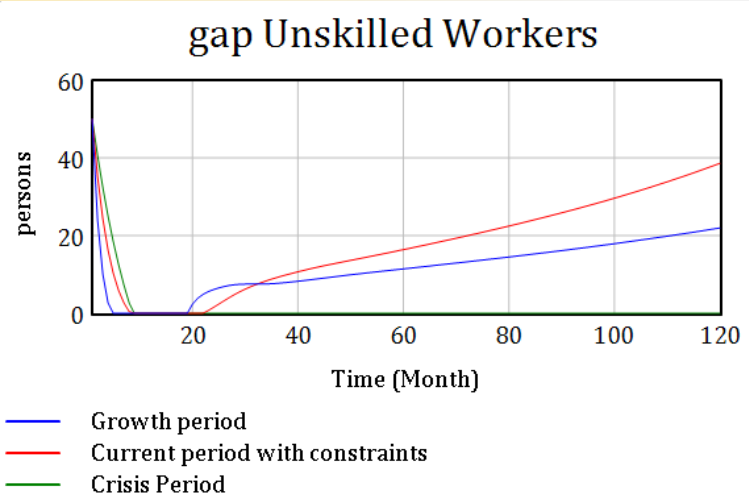
Key Trends in Graphs

➢ Conclusions for Unskilled Workers

Unskilled Workers also experience a decline in their numbers during crisis periods, whereas during recovery and growth phases, their recruitment increases with relative ease.



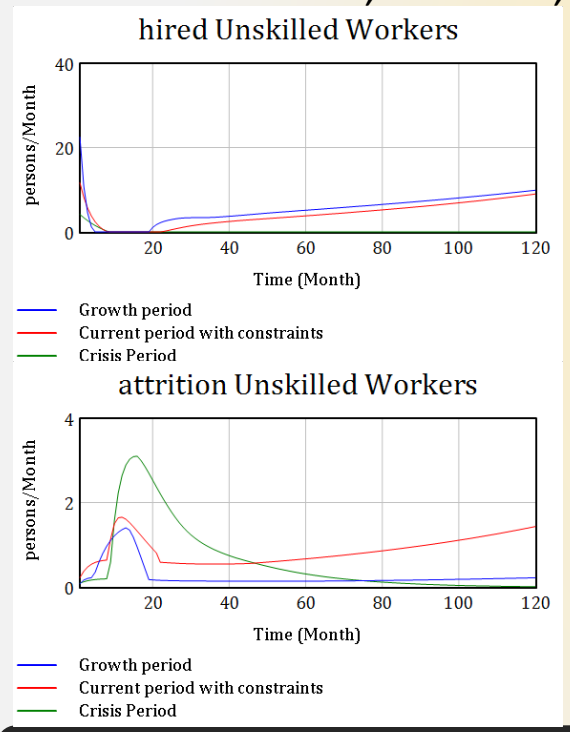


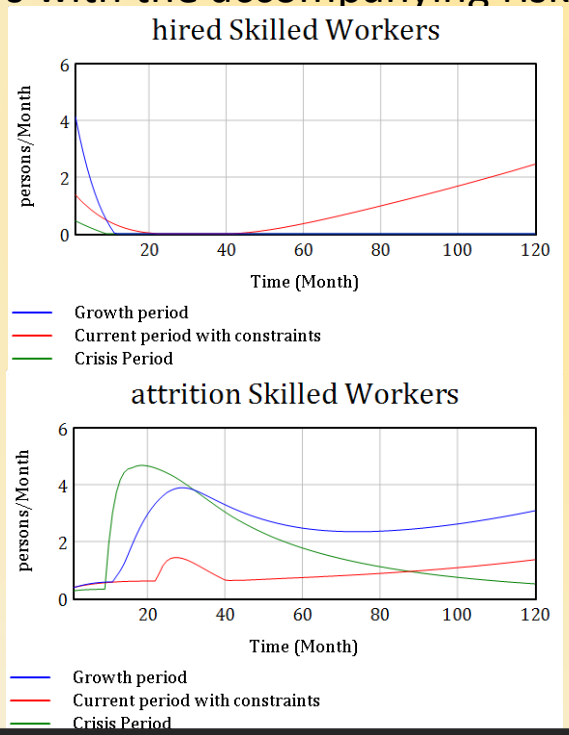


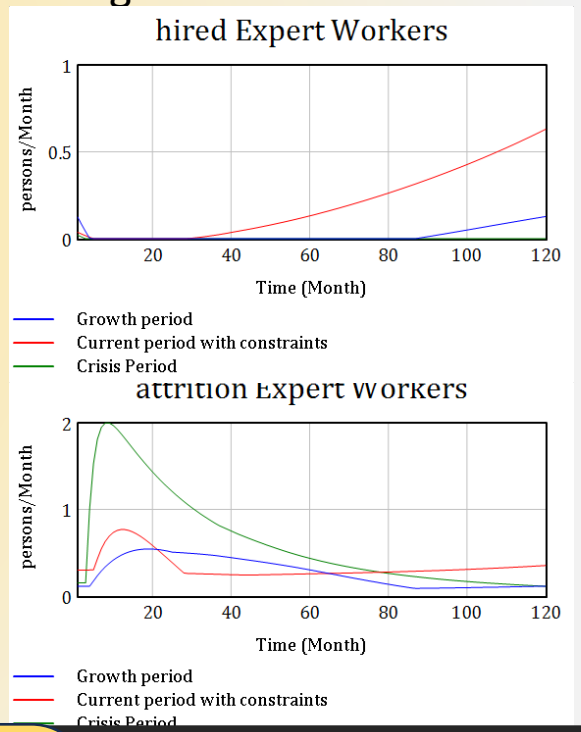
Key Trends in Graphs

➢ Hiring and Attrition Trends

During crisis periods, hiring across all examined grades is virtually nonexistent, while attrition exhibits significant fluctuations at each grade.
In other periods, as expected, hiring increases as economic conditions improve. During recovery and growth phases, attrition also rises; however, this occurs with the accompanying risk of insufficient staffing.



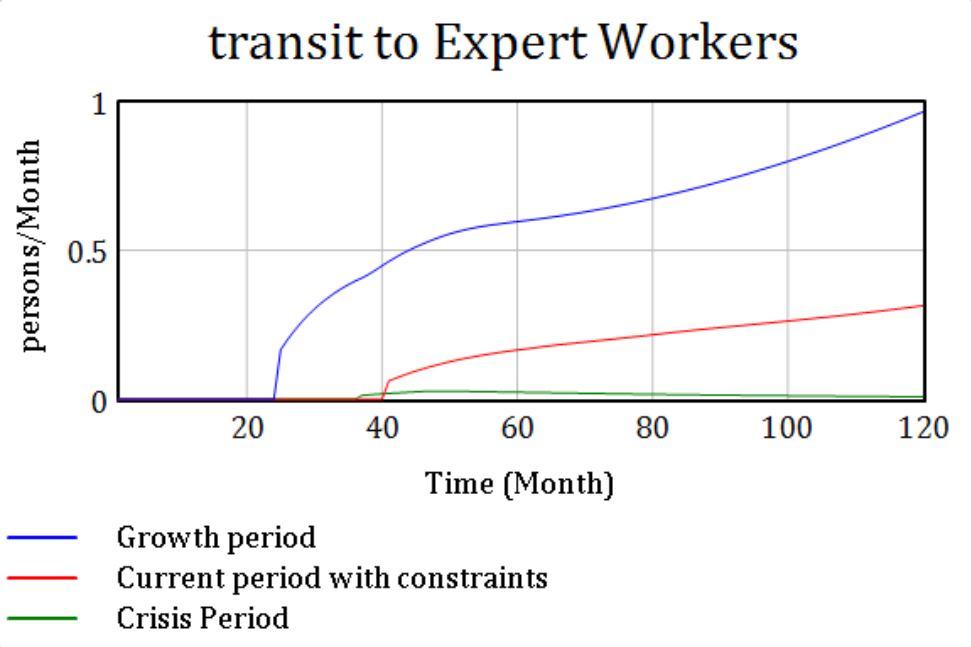


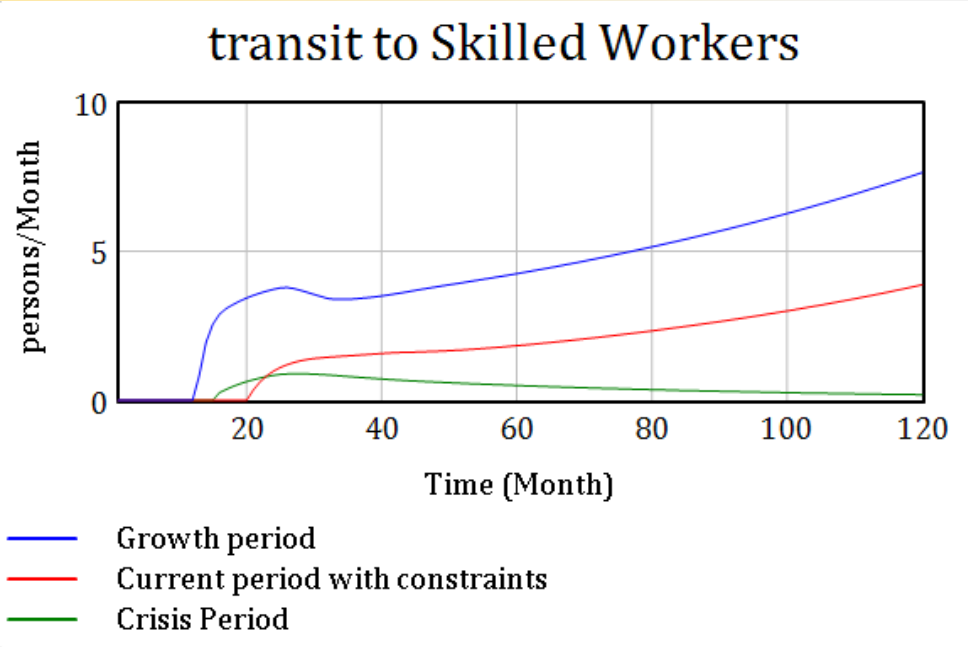


Key Trends in Graphs

➢ Promotion Trends

Training and the transition from Skilled to Expert Workers are key factors for ensuring long-term workforce balance. The charts highlight the company's increased focus on training during growth periods, whereas under current conditions, training activity remains at a more conservative level.





Conclusion

- The model clearly illustrates the dynamic **interdependencies between projects and human resources**.

- The key challenges the company faces are:

  - **Crisis period**: ensuring business survival.
  - **Recovery period (Current period)**: managing the imbalances arising from these dynamic interdependencies.
  - **Growth period:** maintaining stability and mitigating future risks.

- The role of the model across these periods underscores the **importance of strategic forecasting** under different scenarios, enabling the company to respond effectively and navigate the respective challenges.

5 Conclusions

Summary of Achievements & Insights

The study revealed several significant outcomes:

- Development of a **strategic plan** to maintain and expand project portfolios
- Creation of a **forecasting mechanism for future staffing** in line with project needs
- Identification and **mitigation of various risks**, such as under- or over-staffing
- Enhanced ability to make **critical decisions** aimed at maintaining **System balance**

From the application of these methodologies, **key lessons** were derived:

- Modeling serves as a valuable tool for **forecasting future trends**.
- **Early detection of dysfunctions** allows preventive action before issues become critical.
- Considering **alternative scenarios** underscores the importance of business adaptability.
- **Holistic analysis** strengthens strategic project and human resource management.

Bibliography

Craig W. Kirkwood, (1998): Systemic Dynamic Methods: A Quick Introduction

Nikitas Assimakopoulos and Ioannis Theocharopoulos (2009): The Design and Control Systemic Methodology (DCSYM):A multi-agent modeling and operation platform

Research Group of Foundation for Economic & Industrial Research: Giorgos Maniatis, Antonis Mavropoulos, Foteini Stroubakou, (2024) : *Trends, Challenges and Prospects of Construction in Greece*

Russell L. Ackoff, (1971): Towards a System of system concepts

Russell L. Ackoff, (1989): "From Data to Wisdom". Journal of Applied Systems Analysis. 16: 3–9. Retrieved November 8, 2024

Thank you for your attention!

Tsirimpi Aikaterini