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USAGE OF DYNAMIC PLANS IN CIVIL ENGINEERING OF SERBIA

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Abstract. *For a successful realization of a civil engineering project, it is necessary to possess good quality dynamic plans of construction works and of resource involvement. Depending on the type and size of the structure, appropriate type of dynamic plan ought to be used. The plan realization must constantly be observed and updated in order to ensure their full effectiveness. This paper presents the results of a research through a survey of dynamic plan implementation in our civil engineering practice. The results are based on the data processed from the responses to the questions asked in the survey of 45 construction enterprises in Serbia.*

Key words: *construction enterprise, dynamic plans, application.*

1. INTRODUCTION

One of the important factors required for successful realization of a civil engineering project is a good quality dynamic plan of construction works progress. Also important and necessary is the production of dynamic plans of resources. The plan realization must be constantly observed and updated in order to ensure their full effectiveness. It is clear, that in the course of construction, due to a variety of influences, frequent alterations in respect to the original plan are inevitable. Because of this, the original plan must be continuously corrected by including the changed circumstances.

Planning is a procedure where events and activities of the future events are forecast, and then, on the basis of the known data, adopted technology and organization of works, they are connected, dimensioned, distributed/arranged and control of their execution is conducted. The basic goal of the plan is prediction of the realistic scenario of carrying out activities on the project, taking into account the available resources, numerous limitations and potential of alterations in project realization.

The plans are conceived for the future, and future is always marked by uncertainty, and for this reason making decisions about realization of one project in the future must

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not be left to guessing, memory, professional feelings, intuition and similar, but should be reduced to a scientific-deterministic process.

The planning success depends on the accuracy of adopted assumptions on which the future plan is based. If planning is to be realistic, it must:

- Correspond to the production potential and capacities of the construction company,
- Be based on the concrete data,
- Use the acquired experience, and
- Be in accordance with the market conditions

Continuous monitoring and analyzing of production is necessary, as well as permanent enhancement of planning. This means experience of errors observed in planning on one structure, can be used to avoid them in making planes for other structures. Without a detailed analysis of conditions under which production is running, planning can become unreliable or even incorrect.

2. REVIEW OF THE HISTORICAL DEVELOPMENT OF PLANNING

Planning is as old as the humanity. The roots of planning concepts lie in the far past (pyramids of Egypt, Babylonian king Hammurabi, The Great Wall of China, …). It is believed that the onset of contemporary planning development is related to the emergence of a parallel dynamic plan, immediately prior to the WWI.

Modern history of planning begins with *Gantt* (1861-1919). The first plans, which apart from the duration of work, show the real calendar time, occur several years prior the to the First World War, and were known as the "*Gantt charts*". They were named after the US engineer and consultant who developed them, *Henry Gantt*.

Development of industrial, chain production brought about improvement of Gantt charts, which engendered cyclograms – a special type of plan useful for the works which are repeated in cycles. Similar to it is the orthogonal plan which is applicable for the structures which have one dimension expressed – such as linear civil engineering structures. Different variants of these (linear) plans rose and developed under a variety of names since early sixties of the previous century.

Emergence of increasingly complex structures, where planning with existing methods did not produce satisfactory results, and the want for the planning method which would facilitate computer use, brought about development of network planning. The first theories of network planning first emerged in the USA and France. Several hundreds of various modified methods of the network planning technique are known to be derived from two basic methods : *CPM* and *PERT*.

3. TYPES OF DYNAMIC PLANS IN CIVIL ENGINEERING

Parallel dynamic plan (Gantt chart), *Figure 1*, as the oldest is at the same time the most used form of dynamic planning in civil engineering, whether it is used for planning of works execution of resource involvement planning. The classical parallel plan with its simple presentation method is applicable for a small number of work phases and at the low level of project detail, as well as for the papers which do not have a cyclic or linear

character. It is very suitable for monitoring of work execution progress, because it facilitates comparative representation of the planned and of the actually executed works.

Nowadays, the parallel plan is mostly used as a graphic interpretation of the network plan (created by termination of the network plan). For this purpose, software packages such as MS Project or Primavera are used for their production. In such parallel plans, the representation possibilities are great. Some of them are: arrangement and formatting of the text, heading, legend, lines (form, style, color, etc.), symbols for presentation of activities, etc. Computer software facilitates presentation of relations between the activities in a Gantt chart, but in the plan itself it is hardly distinguishable and fairly unclear. Also, there is possibility of presenting the sum of activities, e.g. by the type of the works or by some other criterion or key-boundary events, for example, significant dates in the project, such as beginning and ending of some works, or parts of a structure. Presentation on of sum of activities is particularly convenient, because various detail levels of the plan are obtained in the same plan.

Orthogonal dynamic plan*, Figure 2*, as a plan displaying execution of works in the space-time system, is the most suitable for planning of works of low-rise and long structures, thus it is most frequently applied in planning the construction of roads, tunnels, pipelines, bridges, viaducts. For easy reference, it is customary to provide a sketch of the structure above the orthogonal plan, so the location where works take place can be easily viewed (in the figure 2, road construction orthogonal plan is presented). Above the plan, there is a sketch, that is a profile of the road surface, where the position of the viaduct as well as the parts of the alignment in the cut and fill and the tunnel.

ORDINAL NUMBER	WORK PHASE DESCRIPTION	MEASUREMENT UNIT	QUANTITY	JUL 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	AVGUST 1 2 3 4 5 6 7 8 9 10 11
1	FOUNDATION EXCAVATION	m^3	250	2	
2	FOUNDATION FORMWORK	m^2	80	6	
3	GRAVEL BASE BELOW FOUNDATIONS	m^2	300	8	
4	REINFORCING OF FOUNDATIONS	kg	1456	5	
5	CONCRETE CASTING OF FOUNDATIONS	m^3	73	9	
6	DISMANTLING OF FOUNDATION FORMWORK	m^2	80		3
7	FILLING EARTH AROUND FOUNDATIONS	m^3	10		4
8	CELLAR WALLS BRICKLAYING	m^3	15	7	

Fig. 1. Parallel dynamic plan – Gantt chart

For planning of construction works execution at structures which have one dimension pronounced, and where the works repeat in a certain interval – cycle, it is most appropri-

ate to use cyclogram. In the time-space system, the activities are represented in a linear fashion. The cyclogram characteristics are known: elementary, production and sequential course, step or module of the course, rhythmicity and arhythmicity of courses, stabilized and non-stabilized course, as well as the critical proximity point.

Cyclogram planning is in essence, fine planning which best demonstrates all its advantages in planning in: industry (chain, sequential production), prefabricated elements production, their transport and assembly, rationalized classic technologies, large volume formwork, form tables, tunnel formwork.

Depending on the type of planned works, the following cyclograms are being used: linear, parallel, circular or vector.

Figure 3 represents a cyclogram plan of housing building works execution.

Methods which enabled efficient solving of problems of planning and management of complex systems, as well as optimal usage of available resources and finances are the network planning techniques. From the methodological aspect, the network planning techniques make possible a precise division of the structural analysis and the time analysis, thus enabling increasing use of computers.

Network planning techniques are divided to the methods oriented to events and methods oriented to activities, and whether they use deterministic or probabilistic calculus of activities ration.

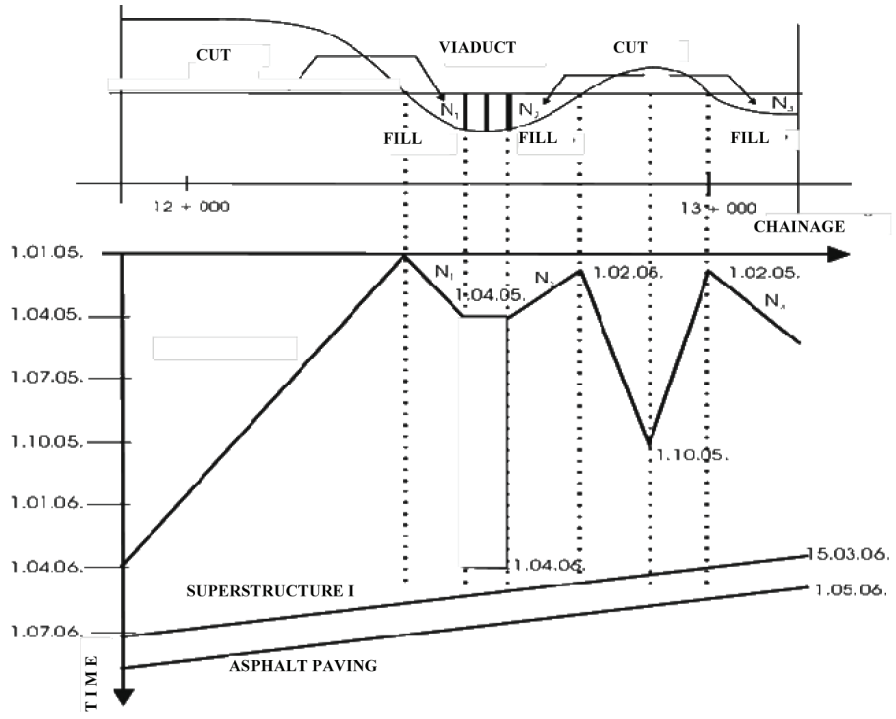

Fig. 2. Orhotogonal dynamic plan

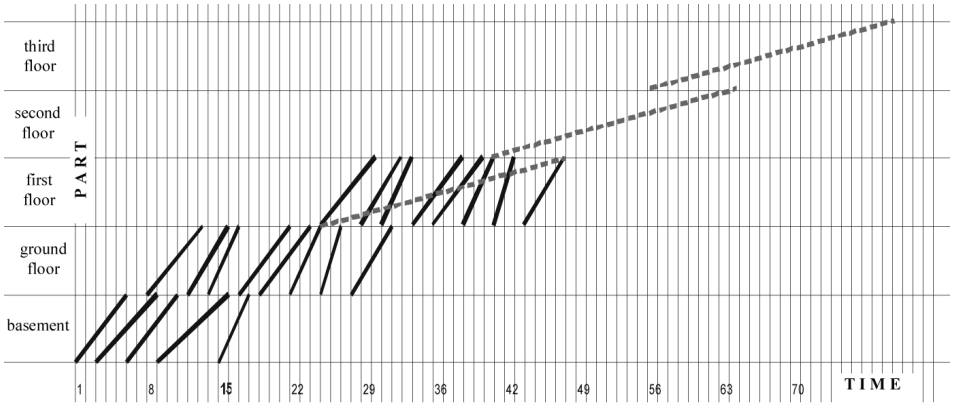

Fig. 3. Cyclogram (linear) dynamic plan

The most frequently implemented network planning methods, both in the civil engineering and in other areas of science and practice, are the following:

- *CPM* (*Critical Path Method*)
- *PERT* (*Programme Evaluation and Review Technique*),
- *PDM* (*Precedence Diagramming Method*)

Critical Path method is a deterministic method used in planning when time of duration of individual activities can be accurately determined (e.g. on the basis of norms and standards in civil engineering).

Program Evaluation and Review Technique is a probabilistic method used in planning of complex projects when it is not possible to accurately and specify duration of activities, but instead predictions are made within certain boundaries.

Both (*CPM* and *PERT*) methods are basically a graph with arrow lines and nodes, which represent an oriented graph of activities and events. Such concept of a network diagram is known as Arrow Diagram Method. PDM (*Precedence Diagramming Method*) is a network diagram based on another concept, the so called *Activity On the Node*. From the viewpoint of computer application, this proved to be a relatively better technique. This network planning method, allows establishment of complex relations between the activities in the diagram. In the *PDM* method, apart from the basic relation, *Finish to Start*, three additional types of relations are formulated, *Start to Start*, *Finish to Finish* and *Start to Finish*.

The entry data for analysis of the network plan structure are defined activities and their mutual relations. The entry data for time analysis of the network plan are its structure and duration of activities, as deterministic or probabilistic data. From the time analysis the earliest and latest starts and finishes, activities, and total and free time reserve are obtained, on whose basis critical and non-critical activities and critical path are defined.

After the complete structural and time analyses in the network planning technique, the network plan optimization is accomplished, and it is in fact the essence of the issue, and only thus this technique is fully meaningful.

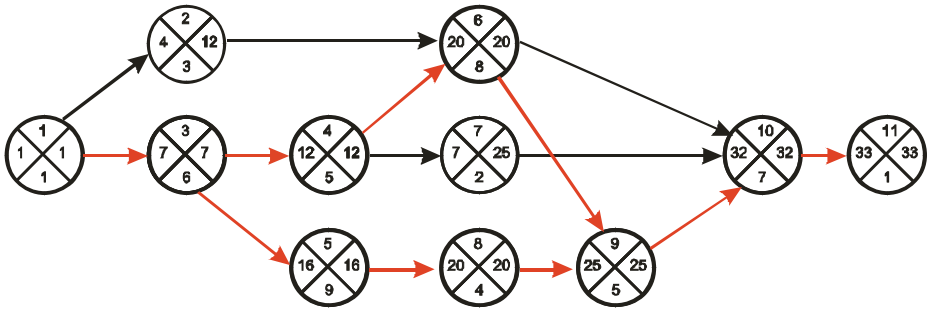

Fig. 4. Network dynamic plan with circles

On the basis of the type and size of the structure, an appropriate type of dynamic plan should be implemented. The widest application of the network planning, due to pronounced diversity of works and projects which can be planned by this technique, and due to a number of advantages (time analysis, various types of relations between activities, critical path, organization, etc.) and simple computer application. Is it also the case in our civil engineering practice, where very frequently construction of the structure lasts longer than it should, and the final cost of the structure is significantly higher than the original? The deadline breach is affected by a variety of factors, such as: lack of finances, lack of material, machinery malfunction, poor organization, relations between investor, contractor, subcontractors, (non-existing) application of dynamic plans, etc. In order to find out the effect of dynamic plans on the deadline and total cost, and in general, to form some idea about the application of dynamic plans in our practice, the survey research was conducted.

4. METHODOLOGY OF SURVEY DATA COLLECTION

The survey included civil engineering enterprises in Serbia which are selected for the list of registered companies, special address books, and through internet. Questionnaires were sent to 70 addresses (via mail, e-mail, in person) and 45 enterprises or individuals responded. The sample is considered representative in the statistical sense, and thus of the realistic conditions.

The survey consists of 28 questions, with offered answers. It was necessary to circle on or more answers, depending on the type of the question. The following list of survey questions with the answers were offered:

1. What is the ownership structure of the enterprise?
   a) state b) mixed
   c) private
2. What is the main activity of the enterprise?
   a) construction b) designing
   c) construction and designing
3. What are the remaining activities?
   a) construction b) designing
   c) engineering d) consulting

4. What is the number of employees?
   a) less than 10 b) 11 to 25
   c) 26 to 50 d) 51 to 100
   e) 101 to 500 f) more than 500
5. What type of civil engineering structures are built by the enterprise?
   a) high-rise structures b) low engineering structures
   c) hydraulic structures d) industrial structures
   e) other
6. Which building system do you apply?
   a) classic construction b) prefabricated construction
   c) classic and prefabricated construction
7. Do you produce dynamic plans for construction works?
   a) yes b) no
   c) occasionally d) only for agreement purposes
   e) only at investors' request
8. If you do not produce dynamic plans, what are the reasons for that?
   a) lack of planning personnel b) lack of software
   c) other
9. In which way do you produce dynamic plans?
   a) without software (manually) b) applying software
10. Which software do you apply?
    a) MS Project b) Primavera
    c) other
11. Are you interested in production of dynamic plans?
    a) yes b) no
    c) maybe
12. What dynamic plans do you produce (level of elaboration)?
    a) general b) operative (detailed)
    c) both
13. What types of dynamic plan do you produce? (it is possible to circle several answers)
    a) parallel plan (Gantt chart) b) orthogonal plan
    c) cyclogram d) network plan
    e) other
14. Do you produce dynamic plans of resources?
    a) yes b) no
    c) occasionally
15. What types of dynamic plans of resources do you produce?
    a) dynamic plan of labor b) dynamic plan of material
    c) dynamic plan of machinery d) dynamic plan of finances
16. How do you determine duration of activities?
    a) by average standards in civil engineering b) by norms and standards in civil engineering
    c) by internal company standards d) by experience
    e) intuitively
17. Do you monitor construction works dynamics?
    a) yes b) no
    c) occasionally d) only at investors request

18. Do you update dynamic plans?
    a) yes
    b) no
    c) occasionally
    d) only at investors request
19. Do you optimize dynamic plans?
    a) yes
    b) no
    c) occasionally
20. How often do you update dynamic plans?
    a) weekly
    b) monthly
    c) quarterly
    d) twice a year
    e) never
21. How often the construction deadline has been breached in last 5 years?
    a) construction works are completed before deadline
    b) construction works are completed on deadline
    c) construction works are completed after deadline
22. What is the time past the deadline?
    a) less than 1 month
    b) 1 to 6 months
    c) 6 to 12 months
    d) more than 1 year
23. What are the most frequent reasons for deadline breach?
    a) lack of finances
    b) lack of material
    c) machinery malfunction
    d) bad organization
    e) lack of synchronization with subcontractors
24. What is the difference between the agreed upon and final cost?
    a) final cost is lower than agreed upon
    b) final cost is higher than agreed upon
    c) the final and agreed upon cost is are equal
25. Upon completion of a structure, the final price is higher than agreed upon for
    a) less than 10 %
    b) from 10 % to 20 %
    c) more than 20 %
26. Upon completion of a structure, the final price is lower than agreed upon for
    a) less than 10 %
    b) from 10 % to 20 %
    c) more than 20 %
27. Is the production of dynamic plans important for successful execution of construction works?
    a) yes
    b) no
    c) could be
28. Would a software for planning contribute to better planning and monitoring of works?
    a) yes
    b) no
    c) maybe

The first 6 questions, as can be seen, refer to the general description of the enterprise, whereas other questions are related to dynamic plans. In the paper only the survey answers to most important questions have been presented.

5. Results of the Processed Data from the Survey

After the survey was published, and it was conducted in the period between 3rd January 2007 and 15th March 2007, a statistic analysis was carried out. For a certain number of significant questions, in the paper, the results of the survey via tables and graphs are presented. Only some of the results are presented:

A) Question number 7: In the *Table 1* (and in the *Figure 1*) responses to the question number 7 are presented: „Do you produce dynamic plans for construction works ". Only 18 of 45 enterprises, which constitute 40.00 %, produce dynamic plans for construction works. 8.89 % of them do not produce them at all, while 15.56 % produces them occasionally and for agreement purposes. It is interesting that 20.00 % of enterprises produce dynamic plans at investors' requests.

Table 1. Production of dynamic plans

Production of dynamic plans for construction works	Numberof enterprises	Percentage (%)
Yes	18	40.00
No	4	8.89
Occasionally	7	15.56
Only for agreement purposes	7	15.56
Only at investor's request	9	20.00
Total	45	100.00

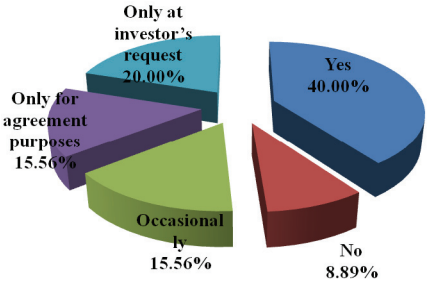

Fig. 5. Production of dynamic plans for construction works

B) Question number 8: To the question number 8, about the reasons for not producing dynamic plans, 21 responses was obtained. The most of them, 13 or 61.90 % responded under *other*, while 4 (19.05 %) mentioned lack of planning personnel and software, respectively. *Other* mostly meant the scope of works was minor, and not requiring production of plans.

Table 2. Reasons for not producing dynamic plans of construction works

Reasons for not producing dynamic plans	Number of responses	Percentage (%)
Lack of personnel for production of plans	4	19.05
Lack of software	4	19.05
Other	13	61.90
Total	21	100.00

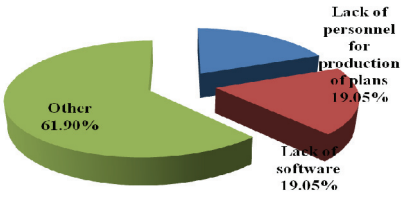

Fig. 6. Reasons for not producing dynamic plans of construction works

C) Question number 9: Of the total number of enterprises stating they produce the dynamic plans, occasionally produce, or produce at investors request, 35 responded, which is 81.40 %. They do it manually, with no application of software. Remaining 8 answers (18.60 %) is positive, regarding planning with software. The results are given in the *Table 3*.

Table 3. Dynamic plans production method

Dynamic plans production method	Number of responses	Percentage (%)
Without software (manually)	35	81.40
Applying software	8	18.60
Total	43	100.00

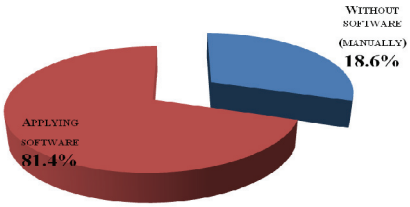

Fig. 7. Dynamic plans production method

Table 4. Software applied in dynamic plans production

Software	Number of responses	Percentage (%)
MS Project	5	50.00
Primavera	2	20.00
Others	3	30.00
Total	10	100.00

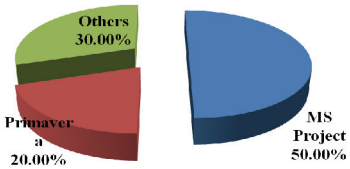

Fig. 8. Software applied in dynamic plans production

D) Question number 10: From the responses to the question 10, (*Table 4*), one may see that half of the enterprises applying software in planning uses *MS Project*. Out of the other half, , 20.00 % plans using *Primavera*, and 30.00 % using some other software. If the total number of surveyed enterprises is observed, the percentage of application of *MS Project* is 11.11 %, *Primavera,* 4.44 % and other software, 6.67 %.

E) Question number 11: In the *Figure 9* is presented the interest exhibited by enterprises for cooperation in dynamic plans production. In the *Table 5* it can be seen that 15 enterprises was interested for cooperation, while 12 is not, and 18 enterprises responded with "maybe".

Table 5. Interest in cooperation in dynamic plans production

Interest in cooperation	Number of enterprises	Percentage (%)
Yes	15	33.33
No	12	26.67
Maybe	18	40.00
Total	45	100.00

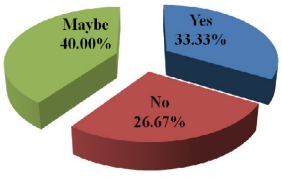

Fig. 9. Interest in cooperation in dynamic plans production

F) Question number 12: Regarding the level of plan elaboration, slightly more than half of the enterprises (57.50 %), produces exclusively general plans (*Table 6*). General plans are not sufficiently detailed to be used for works monitoring. Operative (detailed) plans is produced by the least percentage of enterprises, 12.50 %, and 30.00 % produces both general and operative plans.

Table 6. Level of dynamic plan elaboration

Level of elaboration	Number of responses	Percentage (%)
General	23	57.50
Operative (detailed)	5	12.50
Both	12	30.00
Total	40	100.00

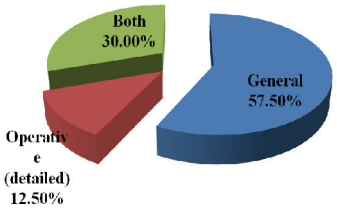

Fig. 10. Level of dynamic plan elaboration

G) Question number 13: There were 29 answers (*Table 7*) to the Question number 13 referring to a parallel dynamic plan – Gantt chart. High percentage of this answer (61.70 %) confirmed that this is the most frequently implemented planning method. It is interesting that only 2 enterprises (4.26 %) apply cyclogram plans, although the most of the surveyed enterprises is in housing construction business, for which the cyclogram technique planning is most suitable. Orthogonal plan is produced only by 3 enterprises (6.38 %), which is only ¼ of the enterprises (12) stating to engage also in the civil engineering projects, characteristical of production of orthogonal plans. Network plans are produced by only 10 enterprises (21.28 %), which is fairly little, regarding the potential of such plans. Three enterprises (6.38 %) stated that they use some other plans which are not on the list.

Table 7. Types of dynamic plans

Type of dynamic plan	Number of responses	Percentage (%)
Parallel plan (Gantt chart)	29	61.70
Orthogonal plan	3	6.38
Cyclogram	2	4.26
Network plan	10	21.28
Others	3	6.38
Total	47	100.00

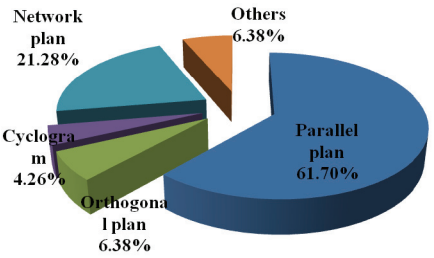

Fig. 11. Types of dynamic plans

H) Question number 14: Arousing concern is the fact that slightly more than a half of surveyed enterprises 52.27 %, do not produce dynamic plans of resources at all, and that 29.55 % produces them only occasionally. Only 8 of them, (18.18 %) produces dynamic plans of resources. Planning of resource usage is equally important as planning of construction, that is, these two types of planning are mutually closely connected and dependent.

Table 8. Production of dynamic plans

Production of resources plan	Number of responses	Percentage (%)
Yes	8	18.18
No	23	52.27
Occasionally	13	29.55
Total	44	100.00

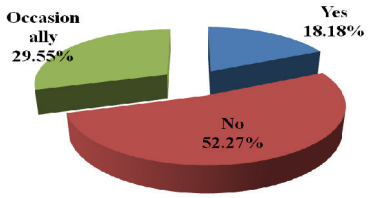

Fig. 12. Production of dynamic plans of resources

I) Question number 15: From the *Table 9* it can be concluded that he responses to the question on the types of dynamic plans of resources are equally distributed. The dynamic plan of labor (manpower) is most frequently produced (31.25 %), followed by the dynamic plans of finances (27.08 %), whether dynamic plans of material and machinery are least produced. (20.83 %). It is important to stress that only a small number of enterprises (only 4 or 8.33 %) produces all the resource plans. Mainly only some of the resource plans are produced (most frequently only the labor dynamic plan or finances dynamic plan).

Table 9. Types of dynamic plans of resources

Dynamic plan of resources	Number of responses	Percentage (%)
Labor	15	31.25
Material	10	20.83
Machinery	10	20.83
Finances	13	27.08
Total	48	100.00

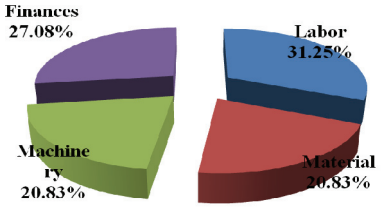

Fig. 13. Types of dynamic plans of resources

J) Question number 16: It is interesting that for determination of activity duration, one third of enterprises still uses average norms in civil engineering. These norms have been present fro more than 60 years and mostly contain items with quotas set for manual execution. Norms and standards in civil engineering (later date norms, adapted to machinery operation) are used in 29.82 % of the cases, and internal norms of enterprises in 10.53 % of the cases. Fairly large percentage (26.32 %) of the enterprises for determination of item (phase) duration time uses experience, which is a very poor method, considering that every engineering structure is unique.

Table 10. Activity duration determination method

Activity duration determination method	Number of responses	Percentage (%)
On the basis of average norms in civil engineering	18	31.58
On the basis of norms and standards in civil engineering	17	29.82
On the basis of internal norms of enterprises	6	10.53
On the basis of experience	15	26.32
On the basis of intuition	1	1.75
Total	57	100.00

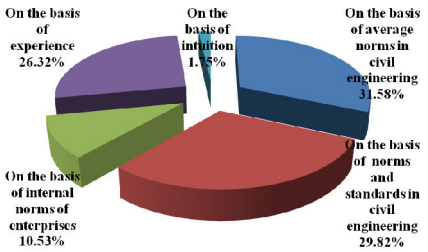

Fig. 14. Activity duration determination method

K) Question number 17: in the *Table 11,* answers to *q*uestion number 17 about monitoring of construction works dynamics are given. Thirty-two enterprises (69.57 %) stated that they do it, whether 10.87 %, responded that they never do that, i.e. that they do that occasionally. Four enterprises (8.70 %) monitor construction works dynamics only at investors' requests, otherwise – no.

Table 11. Construction works dynamics monitoring

Construction works dynamics monitoring	Number of responses	Percentage (%)
Yes	32	69.57
No	5	10.87
Occasionally	5	10.87
Only at investors request	4	8.70
Total	46	100.00

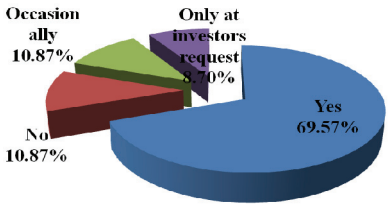

Fig. 15. Construction works dynamics monitoring

L) Question number 18: Dynamic plans updating is a very important part of planning, especially if construction lasts several months, which prevalently is the case. The plans are updated by 40.00 % of surveyed enterprises, while 20.00 % never does it. Around one quarter (24.44 %) of enterprises updates plans only occasionally and 15.56 % only at investors' requests.

Table 12. Dynamic plans updating

Dynamic plans updating	Number of responses	Percentage (%)
Yes	18	40.00
No	9	20.00
Occasionally	11	24.44
Only at investors request	7	15.56
Total	45	100.00

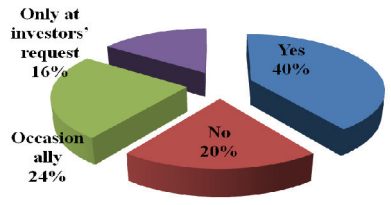

Fig. 16. Dynamic plans updating

M) Question number 19: After dynamic plan optimization, dynamic planning becomes fully meaningful. A large number of surveyed enterprises, 17 (that is, 40.00 %) do not perform optimization of plans at all. Occasionally, dynamic plans are optimized by 37.78 %, and regularly only 22.22 % of surveyed enterprises.

Table 13. Dynamic plan optimization

Dynamic plans optimization	Number of enterprises	Percentage (%)
Yes	10	22.22
No	17	40.00
Occasionally	18	37.78
Total	45	100.00

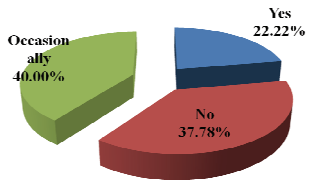

Fig. 17. Dynamic plans optimization

N) Question number 20: Only 4 enterprises (8.89 %) updates dynamic plans weekly. Around one third (31.11 %) performs it monthly, and one fifth (20.00 %) quarterly. It is concerning that semi-annual updating occurs in 13.33 % of the cases, and 26.67 % of surveyed enterprises (*Table 14*) never updates plans. Unless plans are regularly adapted to the changes in construction works and usage of resources, their production and application is pointless.

Table 14. Frequency of dynamic plan updating

Frequency of dynamic plan updating	Number of enterprises	Percentage (%)
Weekly	4	8.89
Monthly	14	31.11
Quarterly	9	20.00
Semi-annual	6	13.33
Never	12	26.67
Total	45	100.00

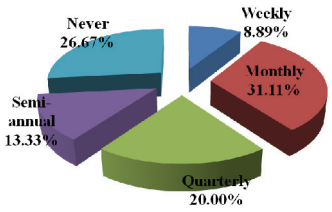

Fig. 18. Frequency of dynamic plan updating

O) Question number 21: Around 60.00 % of enterprises answered that the plans mostly end before deadline, while 7.00 % stated that it is prior to deadline. Yet, significant percentage (33.33 %) answered that the works are mostly completed after the deadline, which means additional costs, as well.

Table 15. Frequency of deadline breach

Frequency of deadline breach	Number of responses	Percentage (%)
The works are mostly completed before deadline	3	6.67
The works are mostly complete within deadline	26	57.78
The works are mostly completed after the deadline	15	33.33
Without answer	1	2.22
Total	45	100.00

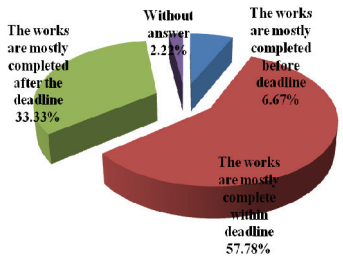

Fig. 19. Frequency of deadline breach

P) Question number 22: It is significant data that there is no breach of deadline for more than 6 months, which may be seen in *Table 15*, and that the highest number of breaches is within one month. However, exceeding the deadline up to 6 months occurs in 33.33 % of cases, which is not good.

Table 16. Duration of deadline exceeding

Duration of deadline exceeding	Number of responses	Percentage (%)
Less than 1 month	24	66.67
1-6 months	12	33.33
6-12 months	0	0.00
More than 1 year	0	0.00
Total	36	100.00

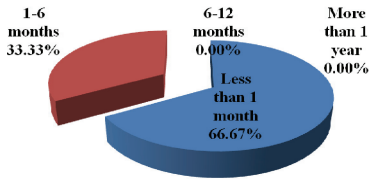

Fig. 20. Duration of deadline exceeding

Q) Question number 23: It is clear that, due to the insecure environment, the most common cause of deadline breaching is the lack of finances, which is confirmed by the half response to question number 23 (*Table 17*). Lack of synchronization with subcontractors is very frequent cause (21.43 %) for project delay. The bad organization is the next most frequent cause for deadline breach 14.29 %, machinery malfunction in 10.71 % and eventually lack of material in 5.36 % of cases.

Table 17. Reasons for deadline breach

Reasons for deadline breach	Number of responses	Percentage (%)
Lack of finances	27	48.21
Lack of material	3	5.36
Machinery of malfunction	6	10.71
Bad organization	8	14.29
Lack of synchronization with subcontractors	12	21.43
Total	56	100.00

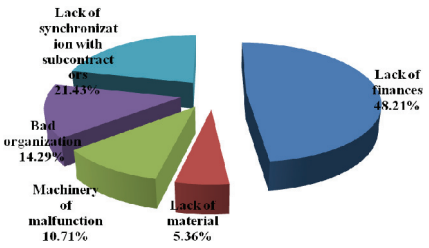

Fig. 21. Reasons for deadline breach

R) Question number 24: Naturally, exceeding the deadline affects the increase of costs, so that as many 70.00 % of constructed structures cost more than agreed, which can be concluded from the *Table 5.24*. On third (27.27 %) of the projects has a final price equal to the agreed one, and only 4.55 % cost less then agreed.
Percentage of increase of final price after construction of the structure is significant (*Table 5.25*). Between 10 % and 20 % the price is increased for almost a half of constructed buildings (46.88 %), whereas this increase is less than 10 % for 43.75 %.

Table 18. Difference between the final and agreed upon price

Difference between agreed upon and final price	Number of responses	Percentage (%)
Final price is lower than agreed upon	2	4.55
Final price is higher than agreed upon	30	68.18
Final price is equal to agreed upon	12	27.27
Total	44	100.00

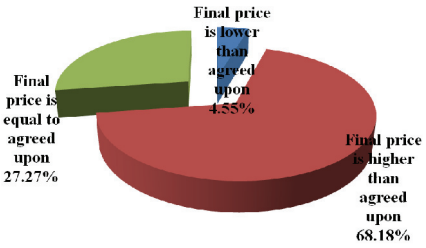

Fig. 22. Difference between the final and agreed upon price

S) Question number 25: Around 10 % of the number of surveyed enterprises which have a higher price than agreed upon stated that this increase amounts to more than 20 %.

Table 19. Percentage of final price increase

Percentage of final price increase	Number of responses	Percentage (%)
Less than 10 %	14	43.75
Between 10 % and 20 %	15	46.88
More than 20 %	3	9.38
Total	32	100.00

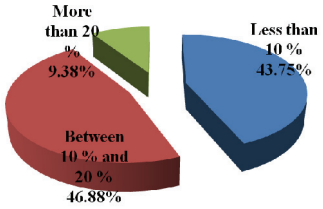

Fig. 23. Percentage of final price increase

T) Question number 26: Total of 8 enterprises replied that the final price is lower than the agreed upon price. In the *Table 20* it can be seen that 7 enterprises has a percentage up to 10 % lower price than the agreed prices, only 1, between 10 and 20 % and none of the enterprises has a price lower for more than 20 %.

Table 20. Percentage of final price decrease

Percentage of final price decrease	Number of responses	Percentage (%)
Less than 10 %	7	87.50
Between 10 % and 20 %	1	12.50
More than 20 %	0	0.00
Total	8	100.00

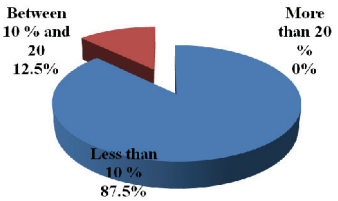

Fig. 24. Percentage of final price decrease

U) Question number 27: Majority of enterprises (73.33 %) agrees that production of dynamic plans is significant for successful execution of works, and 24.44 % thinks that planning can be significant, but need not to. Only 1 enterprise gave a negative answer to this question. On the basis of these responses, on may conclude, that even though

only 40.00 % of enterprises always produces dynamic plans, twice this number thinks that the plans should be produced.

Table 21. Importance of dynamic plans for success of works execution

Importance of dynamic plans for success of works execution	Number of enterprises	Percentage (%)
Yes	33	73.33
No	1	2.22
Could be	11	24.44
Total	45	100.00

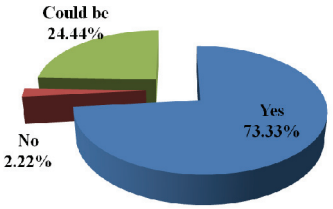

Fig. 25. Importance of dynamic plans for success of works execution

V) Question number 28: The similar situation is with the Question 28 about introduction of software for production of dynamic plans. In *Table 22* one may see that high percentage (75.56 %) thinks that introduction of software would contribute to better planning and monitoring of works, 17.78 % of surveyed enterprises thinks that this could be important, and only 6.67 % declared that introduction of software would not contribute to improvement in dynamic plan production.

Table 22. Importance of introduction of software for success in planning

Importance of introduction of software for success in planning	Number of enterprises	Percentage (%)
Yes	34	75.56
No	3	6.67
Could be	8	17.78
Total	45	100.00

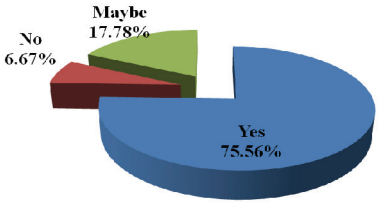

Fig. 26. Importance of introduction of software for success in planning

6. CONCLUSION

On the basis of the survey results it can be concluded that the level of application of dynamic plans in our construction economy is very low. Construction works dynamic plans are produced in a small number of cases, and mostly for the purposes of agreement signing or because it is an investor's provision. Their production mostly comprises a manual production (without software application) which is very difficult when it comes to the detailed planes and generally plans with a large number of phases and items. When it comes to optimization and updating of plans, nowadays it is practically inconceivable without computer application.

Even if the dynamic plans of construction works are produced, those are mainly general plans which, as their name suggests, only serve for general evaluation of times and costs. These plans cannot be used for monitoring of works, control and correction due to

occurred changes. Mostly used still is the parallel dynamic plan known as Gantt chart, (61.70%) due to its simple production and usage. However, a Gantt chart produced without a network plan is not suitable for profound analyses, such as the duration or optimization analyses. Using experience to determine activity duration times is not good, because of construction conditions unique for every construction project. It is only a rough estimate of activities duration which cannot be a basis for production of plans and their analysis. Naturally, a produced plan in its own right is not much of a deal if it is not accompanied by realization and updating, because alterations always occur. Plan updating should be performed at least once a month, and preferably every week.

The deadline breaching, is mostly affected by the lack of finances, owing to the unstable environment, even though the relations of contractors and subcontractors and investors also bear importance. Also internal relations in the contracting enterprises affect breaching of deadlines and agreements.

It is clear that production of dynamic plans represents a significant part of successful works execution and that introduction of software would contribute to better planning and monitoring of works, and thus to better business of construction enterprises

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KORIŠĆENJE DINAMIČKIH PLANOVA U GRAĐEVINARSTVU SRBIJE

Milorad Zlatanović, Biljana Matejević

Za uspešnu realizaciju građevinskog projekta potrebno je imati kvalitetno urađene dinamičke planove izvođenja radova i uključenja resursa. Treba primeniti odgovarajuću vrstu dinamičkog plana, zavisno od vrste i veličine objekta. Da bi ovi planovi imali svoj puni smisao treba vršiti njihovo stalno praćenje i ažuriranje. U ovom radu su prikazani rezultati istraživanja putem ankete o primeni dinamičkih planova u našoj gra]evinskoj praksi. Rezultati se baziraju na obrađenim podacima iz dobijenih odgovora na pitanja postavljena u anketnom ispitivanju 45 građevinskih preduzeća u Srbiji..

Key words: *građevinsko preduzeće, dinamički planovi, primena.*